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CONTENTS.

EDITORIAL: PAGE
Paragraphs ... 367
ILLUSTRATED ARTICLES:
Applications of Electricity to Agricultural Work—II ... 369
Electricity at the World's Fair ... 370
The Electric Conduit on the World's Fair Grounds—II ... 371
The South Staffordshire Electric Road ... 372
The Induction Motor: Who Invented It? by Rankin Kennedy. 372
The Ewing Magnetic Curve Tracer ... 373
Manganin ... 373
A Universal Transformer, by Giulio Appolonj ... 374
Test of an Improved Parsons Condensing Steam Turbine ... 375
Experimental Studies of the Differences of Potential Generated through Contact of Metals, Liquids and Dry Electrolytes—II., by Walter Negbaur ... 377
The Death of Jay Gould and Its Effect Upon the Stock Market ... 380
Root Boilers at the World's Columbian Exposition ... 381
The Lundell Motor ... 381
The Jeffrey Electric Coal Drill ... 381
General Electric Company's New Incandescent Lamps ... 382
The New York Safety Steam Power Company's Boiler ... 382
Automatic Time and Dating Stamp ... 382
The Wirt Electric Indicators ... 382
MISCELLANEOUS:
Notes on the Effect of Harmonics on the Transmission of Power by Alternating Currents, by Henry A. Rowland ... 368
Series Electric Traction: A Reply to Nelson W. Perry, by Cary T. Hutchinson ... 368
The Modern Development of the Dynamo; by Prof. W. Kohlrausch ... 371
The New Westinghouse Lamp ... 374
A High Tension Transmission of Power Plant ... 374
Performance of an Overhead Traveling Crane, Operated by a Single Electric Motor, by Anthony Victorin ... 375
Chronological History of Electricity, by P. F. Mottelay ... 378
Commercial Electrolysis—II., Emile Andreoli ... 379
The Cost of Electric Supply—II., by Dr. John Hopkinson ... 379
Oil Versus Air as an Insulating Medium—III., by J. W. Williams ... 380
FINANCIAL INTELLIGENCE: The Electrical Stock Market, 383; New Incorporations, 383.
SPECIAL CORRESPONDENCE: New York Notes, 383; Western Notes, 384; Philadelphia Notes, 384; Pittsburgh Notes, 384; New England Notes, 384; Canadian Notes, 384.
NEWS OF THE WEEK: 385; The Electric Light, 386; The Electric Railway, 386.
INDUSTRIAL AND TRADE NOTES ... 385
BUSINESS NOTICES ... 386
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 386

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Neutral Points on a Dynamo. IN a paper recently read before the California Electric Society, Mr. C. O. Poole calls attention to a phenomenon which he noticed on the commutator of a constant current dynamo for 2,000 volts, showing the existence and position of the neutral points in the coils of the armature. Carbon brushes were in use on a 10-inch 150-part commutator, and it was noticed that the little particles of carbon adhering between the commutator bars glowed perceptibly, but only between those bars further than about two inches on either side of the brushes, where the potential was estimated to be about 37 volts between two bars. Those nearest the brushes corresponded to the neutral field and, therefore, very little, if any, voltage existed there between successive bars. Changes of the position of the neutral field accompanying changes in the load, could readily be seen by the shifting of this spark region to different parts of the commutator.

Ewing's Magnetic Curve Tracer. THOSE who have taken an interest in our former description of Prof. Ewing's magnetic curve tracer will be pleased to find in our columns this week an illustration and description of the completed instrument as it has been constructed for its inventor by a well known firm of English instrument makers. At the time this instrument was first described before the meeting of the British Association in August, it created widespread interest because of its ingenuity and its practical application to the determination of the magnetic properties of iron. The exhibition of the completed instrument at the recent meeting of the Cavendish Physical Society was accompanied by the description, for the first time, of the continuous commutator which has been invented for use with the curve tracer. This, as will be seen from the description, was necessary owing to the fact that the variation of the magnetizing current had to be continuous and gradual, the magnetic cycle being performed in about one-tenth of a second.

The Introduction of the Overhead System in England. THE conservative Englishman has again, as in other cases, waited until a new electric industry has been well tried and developed in this country, and after coming here to inspect our overhead trolley railways has concluded that he is now safe in introducing them in his own country. In doing so he, unintentionally perhaps, pays American electricians a compliment, for which due thanks. But instead of accepting the results of the experience of American practice he tries at once to improve on it, and starts in with a "new and improved" method of running the trolley wire. Whether it will be a success remains to be seen. We hope it will be, both for his sake and for ours, as it certainly is an improvement from an æsthetic standpoint which we would be glad to introduce, if practical. Perhaps his trolley wheels will behave better than ours, and will not spit fire and go off on their own account when led around sharp and abrupt corners at a rapid speed. At all events, our advice to him is to train his men well in the art of replacing the trolley wheel on the trolley wire after it has jumped off, as it may not be an easy matter with that particular design, because the trolley wheel has an independent movement on the end of its arm. If he adopts 350 volts because he is compelled to by English law we are sorry for him; but if he does it from choice, we are sorry for those who have to pay the bills. Five hundred volts has been adopted here after long experience; why should he want to go over the same ground again? Does it go so much against the grain to follow American practice?

Cholera and Ozone. THE fact that electricity enables ozone to be generated cheaply and on a large scale may have a most important bearing in the future as a sanitary measure, more particularly, however, in relation to the cholera epidemics. That some connection exists between the spread of cholera and the scarcity of ozone in the atmosphere there appears to be little doubt from observations begun as early as 1884 and continued ever since. There is a normal amount of ozone in the atmosphere, and it appears from these observations that at places where the cholera existed the amount of ozone in the atmosphere was below this normal, sometimes even to a very marked degree. Moreover, an increase in the epidemic in certain localities seemed to go hand in hand with a diminution of the amount of ozone in the air. During the early part of the 1884 epidemic in Paris and Marseilles the quantity of ozone in the air was found to be decidedly below the normal. This itself would point to some connection between the two, but an additional fact of great importance is that tests made at the same time in other places which were free from the epidemic showed the presence of a normal amount of ozone. Tests made since by numerous observers appear to have confirmed this coincidence. The fact that some relation may exist between the two would not be surprising, as cholera, we believe, is now recognized as a germ disease, and ozone is well known to be a very effective germicide. It is, moreover, an excellent means to use, because if properly made it is not in the least injurious to human beings. When made by chemical processes or from oxygen, it may be injurious, but this is owing to impurities or to the presence of untransformed oxygen. If, however, it is made of air ozonized by means of electricity it has been found to be quite uninjurious. Mr. P. de Puyt recently made some very interesting and instructive compilations regarding this matter, and urges very strongly the use of ozonized air, not only as a destroyer of germs in hospitals, lazarettos, schools, public houses and other places, but also as a preventive in the case of a threatened epidemic. Eleven to 12 centigrammes per litre of air, which is easily produced by electrical means, and was formerly claimed to be a dangerously large quantity, he says has been found to be perfectly harmless even for infants, if made by electrical means. He also compiled the following interesting figures: During the month of July, 1884, while the cholera epidemic was at its worst in Marseilles, the mean quantity of ozone in the air was .86 as compared to 2.17 during 1883. In Paris even greater difference was found. During the maximum period of the epidemic in November, 1884, it was .44 as compared to 1.82 for the same period in 1883. Moreover during the two weeks when the mortality was greatest the amount of ozone in the air was as low as .27 as compared to 2.0 for the same period in 1883. Furthermore during several days when the air was charged electrically, more than was usual, the epidemic was found to diminish in its severity. Such coincidences are certainly very striking and warrant the most careful attention and study on the part of physicians and boards of health. There is time now before the threatened cholera epidemic in this country next summer to institute experiments and make preparation which the gravity of the subject and the data already at hand surely warrant.

A Little Knowledge Is a Dangerous Thing. MECHANICAL, civil and other engineer who are not electricians cannot have the fact too strongly impressed upon them that work or power measured or represented in electrical terms is as much dependent on the volts as it is on the ampères, precisely as foot pounds of work depend on the feet as well as on the pounds. Ampères by themselves do not, therefore, represent any definite amount of energy unless accompanied by the volts measured between the two points of a circuit at which the energy is to be measured. Through the extended use of constant potential circuits it has become the habit of many to assume that the voltage *is* constant in all parts of the circuit and its measurement is, therefore, often dispensed with. It should be remembered that in all such cases the results are correct only to the degree to which the voltage may be assumed to be constant; that is, if the whole voltage may be 10 per cent. out, the power calculated from the ampères and the assumed voltage will be uncertain to within 10 per cent. Only in incandescent lighting circuits, where the voltage is kept constant, through extreme care, at the consumer's end of the line, can it be assumed as remaining the same. On power circuits it may, and generally does, vary very materially. There are, moreover, many conditions which influence the voltage at the receiving end of a line—as, for instance, the speed of the generator, the resistances of the line, the fuses, instruments, etc., the current on the line (which, in turn, again often affects the speed and voltage of the generator), etc.—so that, to assume the voltage at the poles of a distant motor, while running, to be that engraved by the makers on the face plate of the generator, is almost as bad as assuming the boiler pressure in a steam engine test to be that for which the makers claim it to have been built. Unless the generator is very nicely over-compounded to suit that particular line, and unless its speed remains constant for all loads, even when a heavy load is placed on suddenly, it may cause very material errors to assume the voltage of a motor to be the same for all loads and speeds, and especially so at starting, when from its very nature it takes an abnormally great current. If the efficiency in a test is carried back to the poles of the dynamo, then the voltage at those poles must be taken, in which case the line losses need not be considered separately but will be included in those of the motor. We publish in this issue a set of tests made, presumably, by a mechanical engineer, of the efficiency of an electric traveling crane, in which the author unfortunately does not state whether the voltage was actually measured at the poles of the motor, or whether he merely read it on the makers' face plate on the dynamo. If we may judge from the results, the voltage was not measured at the motor, and possibly not even at the dynamo: nor does he state what the line resistance was nor whether the speed of the generator remained constant when loaded suddenly with 20, 50, or even 80 h. p. The results given, nevertheless, are of some interest, as allowances may be made by an electrician who understands the case; but they might have been made of very much greater interest and value if he had simply measured the voltage, or at least stated that he did not measure it, and had given his reasons for assuming it to have been constant at 500 volts. Furthermore, in giving an efficiency, one ought always to state between what two points in a power transformation that efficiency is taken, otherwise it loses much of its value. Moreover, electrical measuring instruments are not always like scales and foot rules, but to be of value when used in tests they should be accompanied either, preferably, by recent or subsequent calibration, or else their style and the name of their maker should be given so that electricians can form some idea of their accuracy and reliability. In general it is advisable for mechanical and civil engineers to at least consult an electrical engineer before they make electric tests for publication if they want such tests to have their highest value.

Notes on the Effect of Harmonics on the Transmission of Power by Alternating Currents.

BY HENRY A. ROWLAND.

In a recent number of *The Johns Hopkins University Circular* and the *Phil. Mag.* for July, 1892,* I have shown that an iron transformer introduces harmonics of the periods 3, 5, 7, etc.† times the fundamental period into the currents and electromotive forces both primary and secondary of a transformer and that these increased in value as the iron was more and more magnetized.

It is my present object to call attention to the effect of these harmonics on the transmission of power and its measurement. For lighting purposes they are evidently of very little significance, as currents of all periods are equally efficient in producing heat. There is a loss, however, in the fact that they cause more loss of heat in the wires and the iron of the transformers. But for the transmission of power the case is very different. Here the motors are designed to run at speeds dependent on the period; if there is more than one period the adjustment fails, and there is a loss. The harmonics are thus useless in the transmission of power by synchronous motors, and are of very little use in motors with revolving fields. In these cases the harmonics travel around the circuits, heating the wires and the iron without producing valuable work. They then represent an almost complete loss in the transmission of power, and as they may contain 10, 20 or even 30 or 40 per cent. of the current, according to the magnetization of the transformer, they are probably responsible for some loss of efficiency in many cases, as will be shown further on.

Indeed, I believe they are the explanation of many seeming mysteries in the working of alternating current motors.

Special arrangements of condensers and coils can be made to pick out these harmonics so that they become more important than the original period. This may occur accidentally and cause many curious results in the working of motors.

It is, then, of the first importance in the transmission of power that the curves shall be pure sine curves, and dynamos,‡ transformers and motors must be designed in the future with reference to this point. It would seem, also, that most calculations on the efficiency of power transmission by alternating currents must be at fault unless they include the action of the harmonics.

As to the amount of loss from this cause it is difficult to decide in general. With synchronous motors the harmonics simply flow around the wires without producing useful current of any kind. But this may not cause great loss if the resistance is small. Indeed, considerable distortion may represent small loss of power in certain cases and great loss n others, according to the difference of phase of the current and electromotive force in the harmonics.

In the case of motors with rotary fields the harmonics produce fields revolving with velocities 3, 5, 7, etc., times the primary field. Now it is essential for the efficiency of these motors that the armature shall revolve nearly as fast as the field, and hence the efficiency for the harmonics must be very small indeed, and this must decrease the efficiency of the apparatus as a whole.

As to the heating of the wires by the harmonics, it is easy to see that the total heating due to all the currents of different periods will simply be the sum of the heatings due to each of the currents separately.

The effect of harmonics on the hysteresis is much more complicated and can hardly be calculated without further experiment. However, the following hypotheses may give some idea of the action. Let the primary electromotive force be considered unity, and let a_3, a_5, etc., be the electromotive forces of the harmonics. If these acted separately on the hysteresis the total would be:

$$1 + 3\left(\frac{a_3}{3}\right)^{1.6} + 5\left(\frac{a_5}{5}\right)^{1.6} +$$

Again, if they all combined so that the maximum electromotive force is equal to the sum of them all, the hysteresis will be nearly:

$$\left(1 + \frac{a_3}{3} + \frac{a_5}{5} +\right)^{1.6}$$

However, it is hardly probable that this last condition would be often satisfied, in which case this formula would give too great a value. When the harmonics are small this last formula can be written nearly

$$1 + 1.6\left(\frac{a_3}{3} + \frac{a_5}{5} + \text{etc.}\right)$$

As an example, suppose $a_3 = .3$ and $a_5 = .2$ and $a_7 = 1$, these two formulæ give an increase of 10 and 24 per cent. in the loss due to hysteresis.

The current heating is only

$$1 + a_3^2 + a_5^2 + \text{etc.}\S$$

Or, in the example,

$$1 + .09 + .04 + .01 = 1.14.$$

It would seem, then, that the losses due to hysteresis and current heating may be much increased by the harmonics.

I believe the statement has been made that the form of the curve does not influence the hysteresis. This is evidently incorrect, unless we take the top of the curve to reckon from, in which case the statement agrees with the second hypothesis given above if the harmonics are of the proper phase.

To estimate the influence on the efficiency of a plant, assume the efficiency of the dynamo and synchronous motor with primary currents as each equal to 90 per cent., and of the two transformers equal to 98 per cent., and assume that all the currents have the same harmonics as given above. The total efficiency will be 70 per cent. If the harmonics are now added, the 30 per cent. loss will become about 35 per cent., the efficiency will be decreased to 65 per cent. nearly, a loss of 5 per cent. There is too much assumption about this calculation to warrant full belief, and the figures are given more as a challenge to further investigation than as facts. That there is a decrease of efficiency is certain, but the amount must be determined by further experiment and mathematical investigation. But, however small the loss, provided it occurs in the transformers or the dynamos and motors, it may be of great consequence on account of its heating effect, because the output of these is limited by the amount of the heat generated.

The practical conclusion seems to be that transformers and the armatures of dynamos to be used in the transmission of power must be designed for low magnetizations. By experiment with transformers, made by Dr. Duncan in this laboratory, immense distortion of the curves has been found when the induction exceeds 12,000 lines per square centimetre, while the curves are comparatively smooth with only 5,000; hence I scarcely think it advisable to use more than 5,000 for transformers, even though low frequency were used. As to dynamos and motors the limit will depend on the variety of machine used and will not influence the better class very much.

The fixing of the limit of magnetization of transformers at 5,000 causes the output with given current to vary *inversely as the frequency.* As the hysteresis with slow frequency will be less, we may increase the current somewhat to make up for it. As to the exact law, it depends on the relative dimensions of wire and iron. Practically we might estimate for an ordinary transformers that the output varied inversely as the eight-tenth-power of the frequency.

The law that the output varies inversely as the four-tenth-power of the frequency assumes that the magnetization increases with decrease of frequency and thus distorts the curves as shown above.

The immense increase of the size and cost of transformers when distortion of the curve is avoided precludes the use of very low frequencies even were it otherwise desirable.

It is to be noted that the action of the iron in producing harmonics is directly on the electromotive force, and the amount of current flowing will depend on the resistance and the self-induction of the circuit. The resistance, owing to so called "skin" effect, will be greater for the harmonics than for the fundamental period. Self-induction depending on the air will always diminish the harmonics, while if it is due to iron it may either increase or decrease them according to their phase.

The measurement of the energy supplied by an alternating current is also much complicated by the presence of harmonics.

Let the current be

$$C = A_1 \sin(bt + \varphi) + A_3 \sin(3\,bt + \varphi_3) + A_5 \sin(5\,bt + \varphi_5) +$$

and electromotive force

$$E = B_1 \sin bt + B_3 \sin(3\,bt + \psi_3) + B_5 \sin(5\,bt + \psi_5) +$$

The energy transmitted is, then, per unit of time

$$\int_0^1 C\,E\,dt = \frac{1}{2\pi}\int_0^{2\pi} C\,E\,d(bt)$$

If n is the number of complete periods in the primary term, then $b = 2\,\pi\,n$ and the energy transmitted per second becomes

$$\tfrac{1}{2}[A_1\,B_1\cos\varphi + A_3\,B_3\cos(\varphi_3 - \psi_3) + A_5\,B_5\cos(\varphi_5 - \psi_5) + \text{etc.}]$$

An ordinary wattmeter in the form of an electrodynamometer with non-inductive coils would give the correct value of this quantity, but any attempt to multiply the mean electromotive force by the current and the cosine of the phase would lead to an incorrect result unless this was done for each harmonic separately.

It is to be noted that the introduction of condensers to balance self-induction will only work for one period at a time.

Indeed very many of the results hitherto obtained by observers and theorists will require modification in the presence of these harmonics.

It would seem from the above that the transmission of a current for electric lighting is quite a different thing from the transmission of a suitable current for motors. It will be remembered that the transmission in the Frankfort-Lauffen experiment was one of a lighting current alone and that some mystery seems to hang over the motor tests. Can the presence of these harmonics have anything to do with this?

* See also THE ELECTRICAL WORLD of July 9, 1892.

†The periods 2, 4, 6, etc., can evidently be introduced by magnetising the iron of the transformer in one direction by a constant current, or having it originally with an asymmetrical magnetic set.

‡ Dynamos and motors introduce the odd harmonics on account of the variations of the self-induction of the machine, which become very apparent when a strong current is flowing. The armature reactions may also introduce the harmonics.

§ This formula assumes that the resistance is the same for the harmonics, whereas it is greater on account of the "skin" effect.

Series Electric Traction: A Reply to Nelson W. Perry.

BY CARY T. HUTCHINSON.

Mr. Perry's letter in the issue of THE ELECTRICAL WORLD for Dec. 3 scarcely calls for a reply, since nearly all my statements quoted there are admitted to be correct. However, it may interest Mr. Perry to know a little more definitely what my opinion of this series system is:

Movable Switches.—It seems to be premature to make a comparison, as Mr. Perry does, between commutators, regulating devices, or, in general, station appliances and switches placed somewhere on the exposed structure of an electric line and operated directly or indirectly by the passage of a car. A double or triple winding is an excellent thing in its proper place; it is not the winding *per se* that is objectionable, but the method of getting the current to the magnets, the contacts and switches.

Trolley "Wheels."—Mr. Perry has exonerated me from purposely misquoting him in this connection, but to my mind trolley shoes, sliding contacts of any kind or more indirect magnetic switches will be as bad as wheels; any connection made between three wires by means of vibrating trolley poles will prove dubious.

"*40 Ampères.*"—This figure was selected because it has been used for the purpose. Mr. Perry will find it difficult to use more than 40 ampères in his switches and controlling magnets.

"*Sectioning the Line.*"—I can assure Mr. Perry that I did not form an entire misconception of his system; my remark, of course, referred to the "working section." I repeat that this is a serious disadvantage, not an advantage. It blocks the line and necessitates the cars being kept a certain minimum distance apart. This makes the system absolutely impossible for even ordinarily heavy city work. On Tremont street, in Boston, the sections would have to be just one car's length. As I do not know the current proposed, I cannot discuss the question of the length of the feeder sections, but I do not think this to be a point of any consequence; it is the "working" sections alone that I am concerned with.

Overloads.—It may be that Mr. Perry can find patrons for his road who will be satisfied to get out and push on heavy grades; if not, his motors must be made for the greatest load they can ever be called upon to carry. Constant potential motors do burn out, not nearly as often as formerly, but they still will burn out if loaded beyond a "safe excess." This sentence is the gist of the matter. Fifty per cent. is a safe excess for modern motors, and, therefore, a constant current motor must be half as large again as a constant potential motor; but this leaves no margin of safety against the possibility of the passengers having to push; ordinary conservatism would indicate that they be twice as large. This may be an advantage but I hardly think the ordinary railroad man will deem it such.

Double Trolley.—This reference to the Cincinnati case surprises me. Mr. Perry certainly must have heard by this time that the Supreme Court of Ohio overruled Judge Taft on every point. In the decision rendered by the court is the following: "The single trolley system is in use on nine-tenths of the railroads in the United States using electricity. As compared with the double trolley method it is deemed more simple, less liable to disarrangements, much cheaper and not liable to accidents which would blockade the cars. It has proved successful, and its general adoption, with full knowledge of the double trolley method, furnishes strong proof that it is the most approved system." It may be that the Supreme Court of Ohio is not as good a judge of the testimony as Judge Taft, but still it is barely possible that my exertions in that case had some effect. It is Cincinnati against the United States, and it is a matter of common notoriety that the reason for the existence of double trolley roads in Cincinnati lies in the control of the telephone and tramway systems by sympathetic and allied interests.

Claims to Merit.—Lord Kelvin, as quoted by Mr. Perry, states that there is a saving in copper by the use of high potentials. Mr. Perry admits that if this were its only *raison d'être* then it were better consigned to oblivion. The use of high potentials is limited by considerations of danger and insulation, not by the possible saving in copper. Constant current machinery is not cheaper than constant potential; an arc light dynamo costs about $40 per h. p. while a constant potential dynamo can be bought for $30; nor is constant potential machinery as simple as the other—but he claims that the great, the shining merit, lies in the possibility of using the car motor as a generator on down grades and in stopping. This can undoubtedly be done to a certain extent, but how far remains to be proved. But Mr. Perry, although quoting figures from Mr. Sprague's paper, has strangely enough failed to see the following sentence, even though it is in italics: "With the Sprague system, nearly every motor coming to a stop or running on a down grade becomes a generator which is helping to supply the current needed to operate the remaining trains." Such advantages as may be entailed in this procedure are not inherent in the series system only; the parallel system can be operated on this plan if the gain is thought to be worth the complication. It is unquestionably simpler to do so with a series system.

Time will show whether Mr. Perry has attained the desired goal, but I believe, with Mr. Sprague, that "the series system of electric propulsion is absolutely dead."

Applications of Electricity to Agricultural Work.—II.

AN effort was made in the first section of this article published in the last issue of THE ELECTRICAL WORLD to give an idea of the wide field which is offered for the applications of electricity to the operation of farming implements, tools and vehicles. An outline was also given showing the various lines of work to which it is thought the electric motor could be applied in such a way as to give satisfactory and economical service. Under the first heading, namely, the supply of power for stationary machines, the use of the electric motor for hoisting apparatus only was considered. Following the outline given in our former article the application of electric motors to pumping apparatus comes up for consideration. Here again, as was pointed out in the case of hoisting apparatus, the class of work to which pumps are applied in farm work is not very different from the numerous uses now made of pumping apparatus in cities and towns, that is, where electric power can be obtained from established central stations. It will only be necessary then, to call attention to a few of the uses where it is thought electric motors could be profitably used, leaving the question of the source of power to be considered later.

Pumps in farm work may be used, if electric motors are the source of power, for supplying water for drinking troughs, for fire purposes, for fountains, for the sprinkling or irrigation of lawns, gardens, etc., for use in the dairy house, for the washing of vehicles and a number of other purposes, which will readily occur to those familiar with farm work. In the supply of water to drinking troughs, which are often placed in the yards around a central barn, or, in many cases, are distributed through the stables in the basement of the barn, it is only necessary to place an electric pump of any of the standard types now in use for applied to the supply of water in mills, factories, city residences, and similar localities.

In the supply of water for fire purposes the electric motor is particularly available. Here, of course, the tank method of supply, using the pressure of water in the tank to distribute water to any required point, may be used, but probably this supply would ordinarily prove insufficient for the protection of ordinary farm buildings, including of course residences as well as the barns. A better method is that of direct supply, using a motor mounted for the purpose upon a small truck together with a suitable pump. This portable truck could then be used for throwing water upon the fire at any point, connection with the water supply being made at any suitable place provided for the purpose. The current would be carried to the motor through flexible conductors which would be connected to terminals placed at different parts of the yards.

A MOTOR-CHURN.

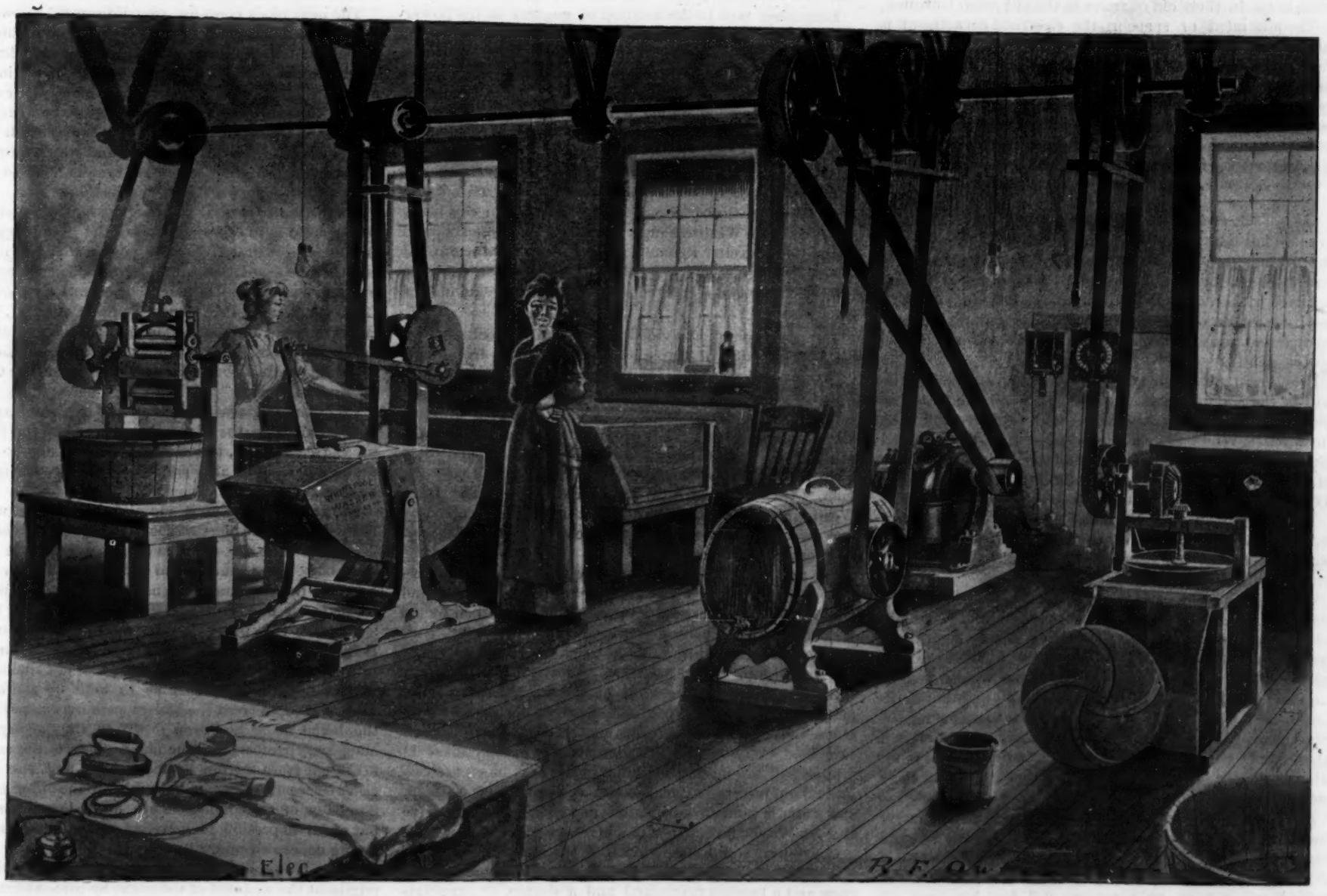
A CIDER PRESS DRIVEN BY AN ELECTRIC MOTOR.

This same portable motor could be used in a similar manner for the sprinkling of lawns or the irrigation of gardens at points reasonably near the supply of current. The truck upon which the motor and pump are mounted could be conveniently hauled about, the wires carrying the current being so arranged as to follow the line of hose through which the water is brought from its source of supply to the pump. Indeed, this is a method already devised for use in connection with electric fire engines, and its application for this purpose would be very similar to that mentioned.

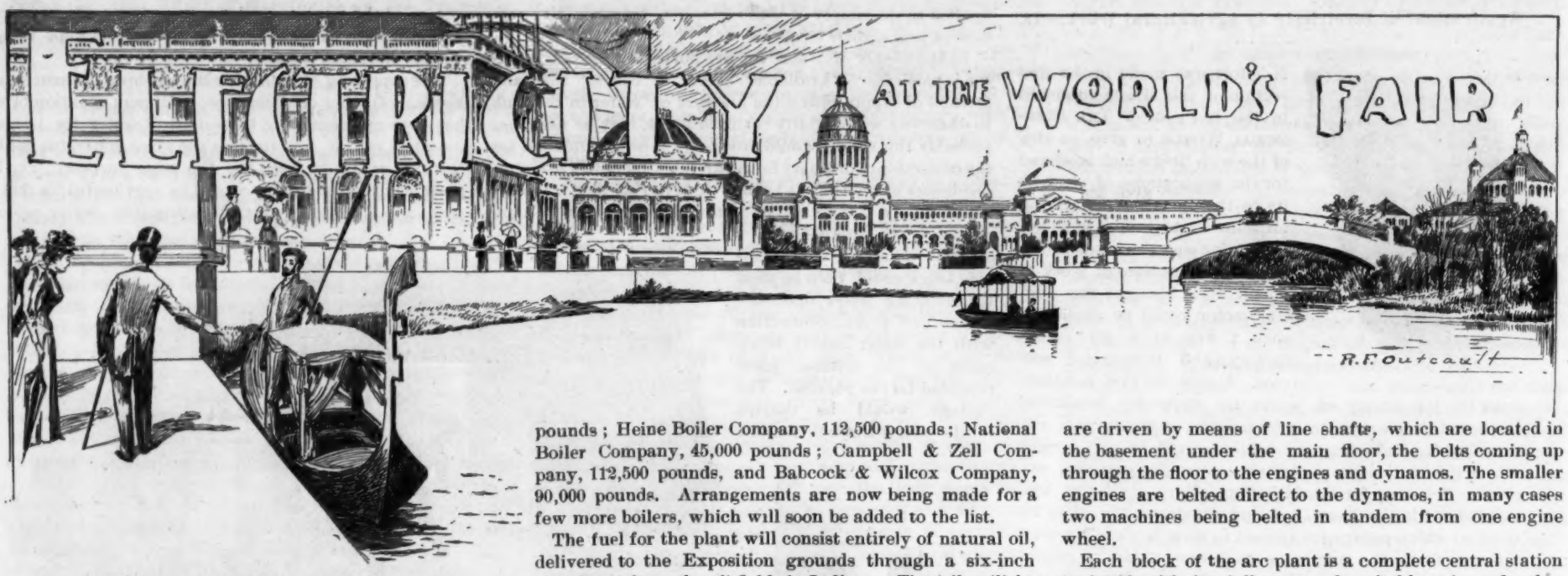
The supply of water for electric fountains could, of course, be made to depend directly on the pressure of water in the supply tank, which, by the electric motor, would be kept at a constant height, or it might be made to depend directly upon an individual motor (a very small one would suffice), which could be started and stopped at will by a switch upon the veranda, or in the house itself. Here again the application is novel only as regards the location of the work to be done, since fountains are already supplied with water by electric motors and kept in operation by the same means.

The supplying of water for the washing of farm vehicles needs no further consideration, and mere mention of what has been said regarding the supply of water for irrigation purposes or for fire uses, as the same apparatus used for the one could be used for the other purpose. The little portable truck and pump would be very useful for this purpose and the attendant directing the water upon the vehicle to be washed could control the current operating the motor by means of a switch placed at the nozzle of the hose which he handled.

The dairy house can be supplied with water in a similar manner to that described for the drinking troughs about the barn, and, of course, the same may be said of water which is supplied to the residence for laundry or drinking purposes. In the regular and constant supply of water to all parts of the premises for any of the purposes mentioned above, or for any others, the electric motor connected to a suitable source of power and ready at all times for operation would be found very satisfactory and reliable.



SOME POSSIBLE USES OF THE ELECTRIC MOTOR IN THE HOUSEHOLD.



(By Telegraph from Our Regular Correspondent.

The special messenger of the Treasury Department, John D. Shriver, arrived from Washington late on Saturday night to procure President Higginbotham's signature to a draft in payment for the first $10,000 worth of souvenir coins. The messenger returns to Washington this afternoon, the World's Fair people having completed the guarantee, and it is expected that the first installment of coins will be received from the Philadelphia mint not later than Saturday next. The demand for coins still continues, and there is no doubt that the entire number will be sold for $1 each.

The officials of the electrical department are pleasantly located in their new offices on the World's Fair grounds. Frederick Sargent, Messrs. Pierce and Monroe and the other chiefs connected with the technical departments made the change some time ago, Prof. Barrett and Mr. Hornsby remaining in their old quarters in the city until Saturday.

The allotment of space in the electrical department is nearly completed. The work of laying foundations for the heavy machinery will commence this week. Work is to be pushed rapidly, the purpose being to have every exhibit ready May 1. Of the work of wiring the light and power circuits twenty-five per cent. is finished, a large force of men being employed. Mr. Keller is confident that there will be no delay in completing the work.

CHICAGO, Dec. 5, 1892.

By mail from our Special Correspondent.)

Much has been said and written about the grandeur of the architecture of the Columbian Exposition at Chicago, and about the magnitude and complexity of the problems involved in the constructional engineering of its buildings; but little, however, has been heard of the remarkable proportion and unusual display which will be offered in the power plant.

People will gaze with awe at the tremendous size of the hall in the Manufactures Building, with its huge trusses of 360 feet span. But no less wonder will be expressed by the enthusiastic visitor as he is carried on one of the elevated passenger cranes in Machinery Building over the long line of whirling flywheels and belts and over the huge dynamos which comprise the exposition power plant.

There are volumes yet to be written on the details of design and construction of this, the greatest of electric power plants, but our space will not permit more than a general outline of its principal features.

The power plant is located on the south side of Machinery Hall and Annex, extending the entire length of the main hall and about 250 feet into the Annex, occupying thus a space about 1,000 feet long by 100 feet wide. Within this space are located the engines and dynamos which develop arc and incandescent lights for the grounds and buildings and power for the other buildings. There are several engines located in various other parts of Machinery Hall and Annex and used to drive line shafting, but the shafts in all other buildings are driven from motors which derive their energy from the main station.

The boiler house is located in an addition immediately south of the power plant, separated from it only by the south wall of Machinery Hall. The main boiler house is 620 feet long by 86 feet wide, and what is known as the boiler house annex is an extension 200 feet long and 86 feet wide. The boilers are arranged in a single row, with their fronts in a line toward Machinery Hall. The level of the firing room is 9 feet below the main floor of Machinery Building, and the view of the boilers is had from the "visitor's gallery," which extends 20 feet into the boiler house on a level with the Machinery Hall floor and communicates with the engine room.

The contracts for boilers are based upon a guaranteed continuous working evaporation from and at 212 degrees, and are rented to the Exposition Company for the term of the exposition for $177.75 per 1,000 pounds water evaporation per hour, the contractors to install and operate the boilers. The contracts thus far let are as follows: Abendroth & Root Company, 45,000 pounds evaporation per hour; Stearns Manufacturing Company (Gill boiler) 45,000 pounds; Heine Boiler Company, 112,500 pounds; National Boiler Company, 45,000 pounds; Campbell & Zell Company, 112,500 pounds, and Babcock & Wilcox Company, 90,000 pounds. Arrangements are now being made for a few more boilers, which will soon be added to the list.

The fuel for the plant will consist entirely of natural oil, delivered to the Exposition grounds through a six-inch pipe direct from the oil fields in Indiana. The oil will be stored in 12 tanks, each 6 feet in diameter by 25 feet long, having an aggregate capacity of about 63,000 gallons. This will amount to between two and three days' run; but when the plant is running its maximum it will empty one tank an hour. The oil storage tanks are located in underground brick vaults at the southeast corner of the grounds, not less than 3,000 feet from the boiler house. The tanks will be filled once a day from the main line. A small pumping plant near the vaults will take the oil from the storage tanks and deliver it to a stand-pipe, which will maintain a uniform pressure on the burners—a five-inch pipe 3,300 feet long connects the stand-pipe to the burners and it has been an object of remark that the energy of 30,000 h. p. will be thus transferred a distance of over half a mile through a pipe five inches in diameter. It would take a sectional area almost as great to transmit the energy by means of electricity with no greater loss than is here engendered.

Returning now to the location of engines in the power plant proper we find, in the centre of that portion within the main Machinery Hall, and directly in line with the main north and south central promenade, the largest "block" of the plant, containing the E. P. Allis 2,000-h. p. quadruple expansion engine, which drives from its 30-foot flywheel two of the Westinghouse 10,000-light incandescent dynamos; the Fraser & Chalmers 1,000-h. p. triple expansion engine, driving one dynamo, and between are two Westinghouse 400-h. p. engines driving each a 4,000-light Westinghouse dynamo. There are also in this block three smaller Westinghouse engines, each directly connected to an exciter dynamo. On account of the unusual size of the engines in this block it was found necessary to raise the floor two feet five inches above the regular floor level.

The power plant is divided into several "blocks," each the entire width of the plant and separated from each other by spacious aisles. In the next block to the west are four 1,000-h. p. Westinghouse compound vertical engines each directly connected to a 10,000-light dynamo. Next to these are found the Buckeye four cylinder triple expansion 1,000-h. p. engine, the Atlas and McIntosh and Seymour engine, each a double tender compound of 1,000 h. p. each. One of these will also drive one of the large Westinghouse dynamos. The next block is occupied by two more of the Westinghouse direct connected 1,000-h. p. engines and dynamos.

The twelve 10,000-light incandescent dynamos above referred to, together with the exciter switchboards and fittings, constitute the station equipment furnished by the Westinghouse company under its contract to furnish all the incandescent lighting for the grounds and buildings of the Exposition.

Continuing on to the west of the incandescent light plant, the next block contains five smaller Buckeye engines, two compounds, a cross and a tandem and three simples. These aggregate about 800 h. p. and drive 14 "Standard" arc light dynamos. In the next block are two Russell engines, a double tandem compound of 600 h. p. and a single tandem compound of 300 h. p. These drive 20 Fort Wayne (Wood) arc machines.

Continuing on to the west into the Machinery Annex, the first block here contains three Lane & Bodley engines, a cross and a tandem compound and a simple, all aggregating about 800 h. p. and driving 16 Thomson-Houston arc machines. The next block contains an Atlas 500-h. p. tandem compound engine and a Bass 300-h. p. cross compound. The former drives ten T. H. machines and the latter six Excelsiors. The next block and that at the western end of the power plant contains a Watertown engine and two Skinner engines, each driving three Western Electric arc dynamos.

One block of arc light machinery is located immediately east of the large central block in the main machinery hall. This contains five Ball and Wood engines, a cross compound, two tandem and two simple, all aggregating about 800 h. p. and driving 16 Brush machines.

All dynamos in the arc lighting plant are rated as fifty light machines. Those connected to the larger engines are driven by means of line shafts, which are located in the basement under the main floor, the belts coming up through the floor to the engines and dynamos. The smaller engines are belted direct to the dynamos, in many cases two machines being belted in tandem from one engine wheel.

Each block of the arc plant is a complete central station in itself with its full quota of switchboards and other equipment.

At the east end of the power plant are three blocks which are devoted to the power generators which develop the power that is transmitted to the other buildings to run line shafts and do other work.

The first of these blocks, that next to the brush arc machines, contains the two Stearns Manufacturing Company (Woodbury) engines, one of 500 and one of 350 h. p., each belted to two Mather generators, two of which are 225 kilowatts and two of 120 kilowatts capacity. The block also contains two Ide engines, each of which drives two "C & C" 80-kilowatt generators. The next block contains three Phoenix engines, one 4-cylinder triple expansion, one tandem compound and a simple. The large engine drives two 250-h. p. Eddy generators and the others one each. The block also contains a 500-h. p. Allis engine directly connected to a Westinghouse railway generator.

The next block contains four Edison 175-kilowatt generators driven by a Ball and an Armington & Sims engine, and also a double Edison multipolar generator, directly connected to the shaft of a 1,000-h. p. Edison engine. There is also to be included in the power plant the circulating pump furnished by the Worthington company, which pumps the water for the condensers, and four air compressors, aggregating about 500 h. p. and which provide compressed air for the sewerage system. These are furnished by the Norwalk Iron Works Company.

There are also several more engines of various sizes which will be located in other portions of the Machinery Hall and Annex, and will derive their power from the main boiler plant. These will be used to drive the long lines of shafting, and among the list may be mentioned a Hamilton Corliss, 500 h. p.; Providence Engine Company, 250 h. p.; Bates Machine Company, 250 h. p.; Golden State Miners and Iron Works, 300 h. p.; Sioux City Engine Works, 150 h. p.; and two Harrisburg Foundry and Machine Company, of 300 h. p. each.

All of the engines above referred to are furnished by their makers to the Exposition company for the period used, free of cost, the Exposition company to build all foundations, make all piping connections and operate the engines.

The steam and exhaust piping for the plant will be all located under the floor of the building. The entire space is excavated to afford a basement with about eight feet headroom. The main steam header is 36 inches in diameter, of boiler iron, and is located under the visitors' gallery in the boiler house. It is 800 feet long, running the entire length of the boiler house and boiler house annex. It is, however, divided into seven sections, the adjacent sections being connected by means of equalizing loops of 10-inch pipe, so arranged as to take up the expansion. The other pipes from the boilers pass over near the roof of the boiler house and drop down to the header, near the Machinery Hall wall. The main pipes to the engines are taken out from the top of the header and run under the aisles between the blocks, branching to the different engines. Some few of the condensers are located on the main floor, but as far as possible they are put in the basement and the piping concealed under the floor.

Water is supplied to the condenser from the circulating pumps at the east end of the plant by means of two pipes 24 and 18 inches in diameter, one of which runs, in the basement, the entire length of the power plant. This pipe is made of $\frac{3}{16}$-inch plate iron with cast iron flanges every 25 feet. The pipe which carries the overflow from condensers is of similar construction, and varies in size from 12 to 40 inches in diameter.

The wires from the switchboard are conveyed under the building by means of numerous branch subways which unite into the main subway which continues through the grounds. The construction of this subway was fully described in THE ELECTRICAL WORLD of Nov. 26, and some illustrations showing its construction appear elsewhere in this issue. The Westinghouse switchboard for this incandescent plant is located in a gallery against the south wall of Machinery Hall, opposite the large Allis engine. There

will be 216 wires running to and from this board, including the leads from the twelve 10,000 light double dynamos and two 4,000-light dynamos, the circuit mains and exciter wires.

For the arc plant there is a separate switchboard for each make of dynamos. The Thomson-Houston board, which is a 40-circuit one and includes the Thomson-Houston and Excelsior dynamos, has 132 wires, feeders and circuits.

We have attempted to give a brief but concise description of the main features of the Exposition plant, but it is difficult to form an accurate conception of the appearance it will have. The whir of nearly 150 belts and revolving flywheels, the rush of exhausting steam, the roar of the oil burners, will present an effect awe-inspiring to even the most accustomed visitor.

To the interested and fortunate visitor who gains permission to go into the basement a scene even more interesting will be presented. The network of hot steam and exhaust pipes, condenser pipes, electric wires, the huge masonry foundations which support the machinery, the whirling belts in the flywheel pits, the revolving shafts, all these, among which and through which he has to climb and bend his way, will be astonishing, to say the least, And yet in the seeming confusion there displayed there will be in reality only harmony and system.

The design and construction of the Exposition power plant is due to the work of Mr. Frederick Sargent, who is the mechanical and electrical engineer of the Exposition. Mr. Sargent has been ably assisted in his work by Mr. John Meaden, the first assistant mechanical engineer, and Mr. R. H. Pierce, the first assistant electrical engineer, and a large corps of engineers, draughtsmen and inspectors.

The narrow limit of time has required the most constant devotion to the work on the part of its engineers. Day and night it is carried on almost unceasingly. But the unusual energy will undoubtedly be rewarded in the development of the most remarkable power plant ever seen.

The Electric Subway on the World's Fair Grounds.—II.

In addition to the information contained in the description given in the columns of THE ELECTRICAL WORLD Nov. 26, our readers will be interested in the accompanying illustrations of the details of the electric subway on the World's Fair Grounds. In the large diagram, Fig. 1, is shown a longitudinal section of the subway, together with sectional views of the single and double subways and of the two modified forms used in special cases. The method of construction will be readily understood from the diagrams, while the nature of the materials used is fully set forth in our former articles on the subject. Fig. 2 shows the construction of the Pierce heavy glass insulators used in the subway, and which are designed to hold two wires each. These insulators were designed by Mr. R. H. Pierce, the first assistant electrical engineer, and are mounted upon locust pins supported by the cross arms, as shown in the large diagram.

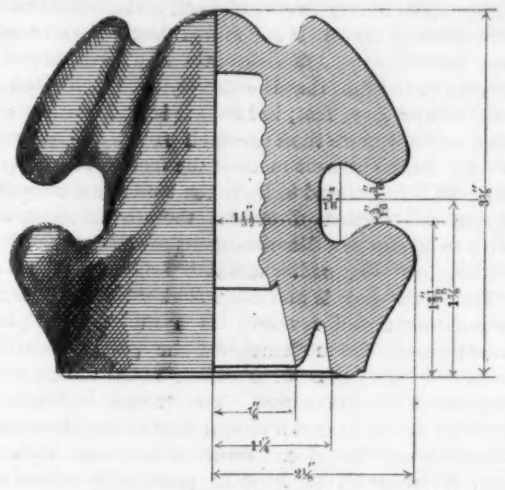


FIG. 2.—THE PIERCE INSULATOR.

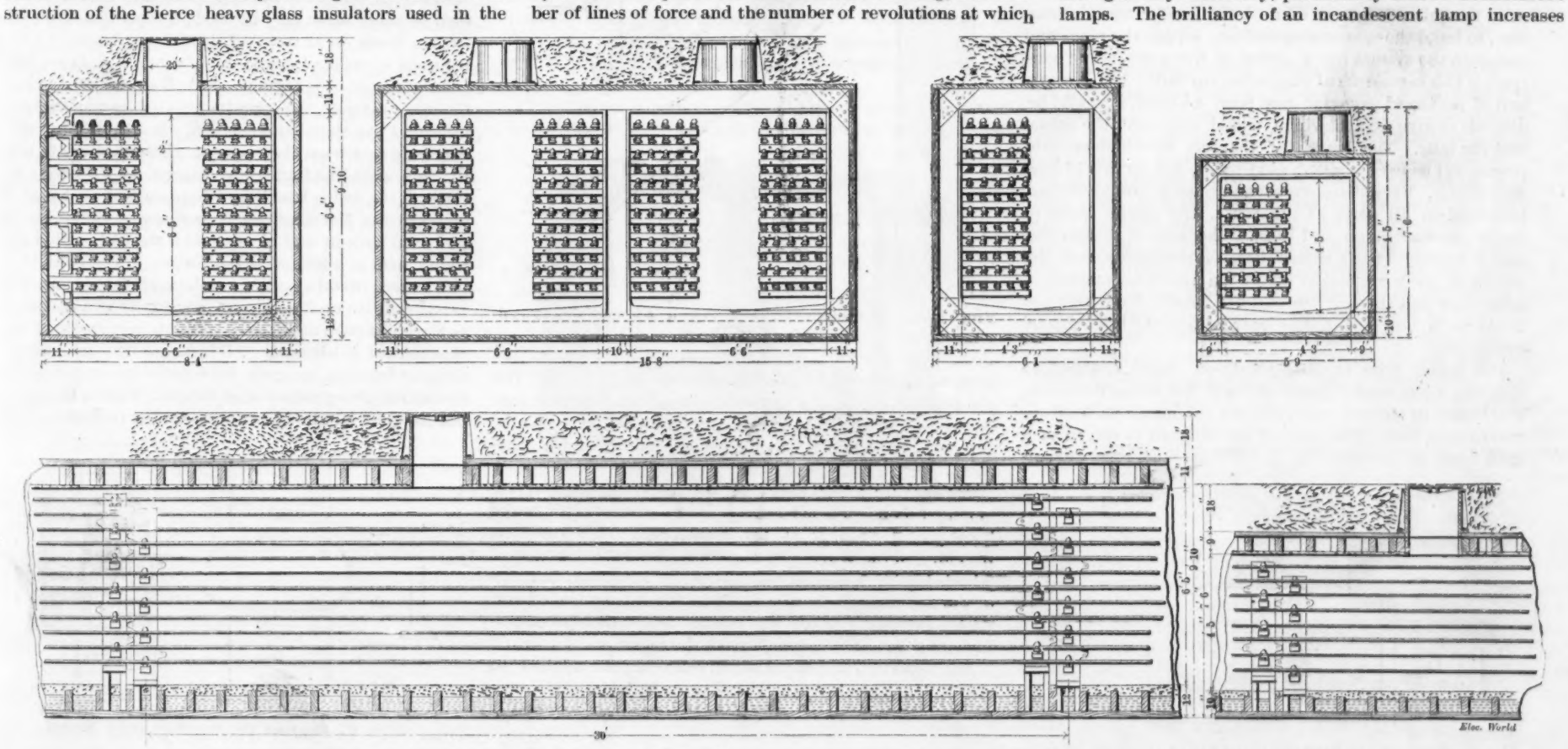


FIG. 1.—LONGITUDINAL AND CROSS SECTIONS OF THE ELECTRIC SUBWAY ON THE WORLD'S FAIR GROUNDS.

The Modern Development of the Dynamo.*

BY PROF. W. KOHLRAUSCH.

The requirements of electric lighting have tended during the past few years to the adoption of dynamos of 500 h. p. and over, and to all appearances the future will demand the construction of considerably larger machines. Such dynamos are usually coupled directly to the engine, and are therefore run at the same speed as the latter. The rotating parts of such large machines, running at present usually at the normal speed of 80 to 130 revolutions per minute, have a diameter of over 9 feet. This dimension is determined in the first place by the room required for the armature winding and by the conditions limiting its form, but the following also plays an important part in the determination of the dimensions of the machine.

The number of lines of force produced by the current flowing through the magnet coils cannot be increased at will by means of a possible increase in the winding of the bobbins and of the current flowing through the same, with a given sectional area of iron in the machine. A saturation point exists with every kind of iron, and this saturation point cannot be exceeded by any infinitely large magnetizing power. As the production and maintenance of the lines of force involve a relatively greater electrical loss in the winding of the bobbins (and consequently a relatively poorer total efficiency) the greater the magnetic density required, we employ in practice a magnetic density amounting to only about 30 or 50 per cent. of the maximum density. There are other reasons as well for using a limited magnetic density, with its accompanying condition of increased iron cross-section and larger machine dimensions in general.

It can hardly be doubted, then, that under such circumstances and in view of the growing demand for larger power units we shall soon reach the bounds of possibility, if the size of the dynamo is to increase in direct proportion to its output.

But, as we have seen, the capacity of a dynamo is limited by the room required for the armature winding, the number of lines of force and the number of revolutions at which the machine is to run. The question therefore comes up as to whether any considerable increase in the speed of dynamos is practicable, and whether this would be of any assistance.

In connection with the feasibility of an increase in the speed, careful attention must be given to its peculiar complicated construction from entirely heterogeneous materials. The rotating iron parts (and in the case of alternating current machines the rigid iron parts also) through which the lines of force flow, cannot be built up of one solid piece; they have to be made up in sheets or in some other divided form. The wires carrying the current must be carefully insulated from the frame of the machine and from each other, and the insulation material (hard rubber, mica, paper, the spun wire coverings, etc.) can only be introduced with great difficulty in the construction of a large machine. Then, again, the magnetic insulation of neighboring iron parts by means of unmagnetizable metals (brass, zinc, copper, etc.) is necessary in certain places. This explains why the purely mechanical engineer, who generally builds machines under far more favorable conditions, so far as materials are concerned, is not yet disposed to regard the dynamo as a machine. That precision in construction which we find in other machines is really lacking in the dynamo, and its calculation, both from a mechanical and electrical standpoint, is not nearly so sure as the calculation of a steam engine.

The increasing demands imposed upon the comparatively small homogeneous rotating parts of a dynamo at an increased speed, in the present general method of building up of these parts, present important and numerous difficulties in the construction, if the speed of a 500 h. p. machine is increased beyond 150 revolutions per minute. The difficulties would be greater with continuous current machines having revolving armatures than with alternators having rotating fields. But we shall undoubtedly learn how to overcome these difficulties so soon as reliable and simple high speed steam engines of suitable capacity are available. At present we, in Germany, adhere conservatively to slow speed steam engines, and rightly too, so long as it is a question of economical working, more particularly of economy in steam consumption. The construction to-day of large slow-speed dynamos rests therefore to a certain extent on a compromise between the builders of steam engines and those making dynamos.

An increase in the number of revolutions of a machine would also be advantageous in various other ways, so long as its economical working is not seriously impaired thereby. Dynamos of the same output become smaller, lighter and cheaper, if the speed is increased. We can indeed increase one factor of the output of a dynamo, namely, the voltage, in proportion to the speed, provided the magnetic field remains constant. In the case of self-exciting machines the output does not, it is true, vary directly with the speed. The increase in speed will, assuming that the safe working of the machine is to be maintained, of course demand more solid construction and necessarily higher cost. The consequence is that the price of machines of similar capacity naturally diminishes very much more slowly than the speed is increased. Similarly the dimensions of a dynamo decrease more slowly than the speed increases, the output remaining the same in both cases, Practical data in this regard differ very much, as comprehensive experience is wanting.

Dynamos require an extraordinarily steady running steam engine to drive them, as the fluctuations in the voltage caused by irregularities in the speed affect the brilliancy of the light very materially, particularly that of incandescent lamps. The brilliancy of an incandescent lamp increases from three to five times as fast as its working pressure. I is for this reason that periodical fluctuations in the speed of the engine are objectionable. Engines driving dynamos must also be unaffected by severe and sudden changes in the load. The consumption of power in lighting work usually varies, it is true, so gradually that any good governor can act well enough. Sudden changes in the load however, invariably occur, when, as the light consumption increases or decreases, additional machines are started up or others shut down, or when machines are changed over from charging accumulators to connection in parallel. In such cases all the governors used at present fail to act perfectly. Whether we shall attain something better with electrical regulation, perhaps between the terminals of the dynamo and the steam valve, experiments will have to decide.

* Abstract of a paper read at the general meeting of the Society of German Engineers at Hanover.

The South Staffordshire Electric Road.

England is at last coming to the conclusion that there may be some merit in the overhead trolley system of electric railroads over the old method of horse and steam traction. A short overhead trolley road built by the Thomson-Houston Company has been operated for some time in Leeds, England, and now a second road has just been opened in South Staffordshire. This line was formerly operated by steam, but the cost per car mile was so great that some other system was looked for. Engineers were sent to the United States to report upon our electric railroads and the natural result was that the directors decided to adopt the overhead trolley system, at least for a portion of the line. It was determined, however, not to use the

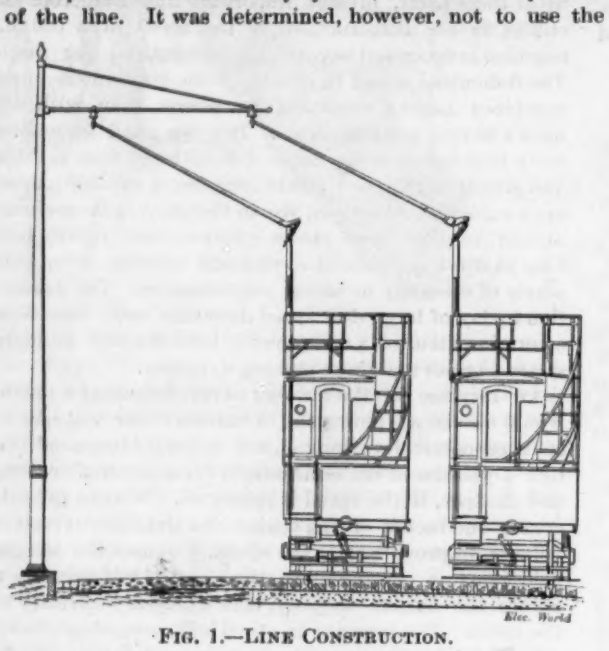


FIG. 1.—LINE CONSTRUCTION.

same devices which are in general use here, but to try something new, the results of which will doubtless be watched with interest by American engineers.

The road was formerly among the most important steam tramways in England. The length is 23 miles, it being a sort of local railroad connecting a number of towns. The number of passengers carried annually amounts to 4,000,000. A profusely illustrated description of this road is given in a recent number of the London *Electrical Review*, to which we are indebted for the accompanying illustrations and data.

An arrangement was entered into with an English company to equip a large portion of the line for electric traction, to build the generating station, supply the plant and maintain the system for a period of five years. The contract is at a certain fixed charge per car mile; but as a system of preferred payment has been adopted, it would be difficult to give figures which would represent the actual cost per mile. The length of the line on which electric power will be used is about nine miles, and on this 16 cars will be run. Very sharp curves and most severe grades are traversed on all parts of the route, the grades being in many cases as much as 1 in 16. The bracket system was said to be out of the question, because the track was in the middle of the road, and to adopt the American method of span wires and stays, it was claimed, would have been too costly on a line which has such a heavy percentage of curvature.

The trolley wire is suspended on arms attached to specially made steel columns about 21 feet above the track. The length of the arm carrying the conductor varies from two to five feet. The arm of the column is stayed by a steel band, as shown in Fig. 1. The steel columns are calculated to bend about 3 feet without injury. The columns bearing the conductors interfere little with the general aspect of the road, and in cases where lamps are suspended they are said to be even an improvement on the old lamp-posts. The trolley wire is a No. 0 hard drawn copper wire, divided into sections of about 880 yards in length. The feeders are insulated with vulcanized bitumen, lead sheathed and armored with a double layer of steel tape; they are run underground and are tapped at half-mile sections, fuses being inserted in each connection from the feeder to the trolley wire. Each half-mile section of trolley line can be completely separated from the feeders without interfering with the working on other parts of the line, so that a fault arising on any part of the conductor would be practically localized. The return circuit is completed through the rail. Fig. 2 shows the section of the fish plate and an elevation of a connected rail.

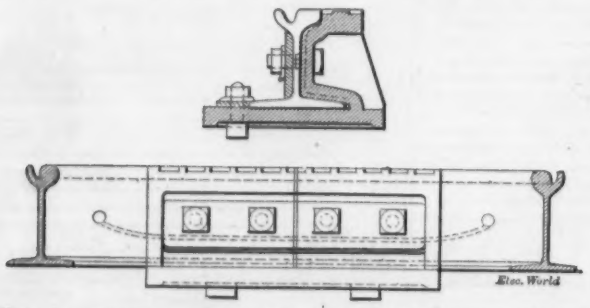


FIG. 2.—SECTION OF FISH PLATE AND ELEVATION OF CONNECTED RAILS.

In order to avoid multiplicity of wires on the streets and especially at the numerous curves, an entirely different system to that used in this country was adopted. This system, which they term an "improved overhead system," will be understood from Fig. 3, in which it will be seen that no matter how sharp the curve, no stays or cross wires whatever are employed. This arrangement depends upon the freedom of movement of the trolley pole. It is said to work very satisfactorily, adjusting itself very nicely to all the conditions of the road and line. The normal distance of the trolley wire appears to be about 10 feet from the centre line of the track. It will be interesting to see whether the trolley will not be apt to jump off the wire, and whether some additional devices will not have to be used to keep it from doing so. At one moment the trolley is about twelve inches off the body of the car and at the next it is out at right angles nearly twelve feet off, and all this change in a few yards of travel. It is claimed that the costly and elaborate nature of the American overhead construction is due largely to the fact that the trolley had a limited play of only two or three feet; in Leeds it is said that the allowable play was not more than one inch from the centre of the track. In the present method the freedom of movement of the pole is calculated to keep the trolley on the wire in a lateral and vertical direction, thereby allowing the feed wire to be run at a direct tangent to the curve of the track without, it is claimed, a semblance of uneven feed.

The trolley pole is made of metal with a ball and socket arrangement and revolves on a movable rod placed in a metal tube. The movement of the pole is controlled by means of springs fixed to a loose collar which works on a pedestal of the ball socket. The trolley is hinged to the pole so as to give it a lateral play in any direction. The trolley wheels are of gun metal 2¼ inches in diameter and can, if required, be kept in position by means of guides which are intended to work upon a pivot or hinge, and are kept in position by springs which allow the guides to open on passing obstructions. In practice, however, it is said to have been found that these guides are unnecessary.

The generating station is situated midway between the two ends of the line, and contains three shunt wound dynamos of 350 volts and 260 ampères at a speed of 450 revolutions. They are driven by ropes from three horizontal cross compound engines, with a rope drum between the cylinders; the indicated horse power is 125 at 100 revolutions and 120 pounds boiler pressure. The rope drums are

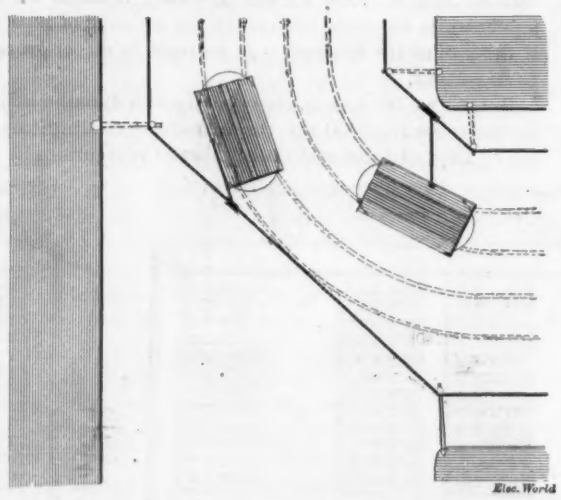


FIG. 3.—CARS ROUNDING A CORNER ON THE STAFFORDSHIRE METHOD.

10 feet in diameter, grooved for nine 1¼ inch ropes. The air pumps are of the horizontal type with surface condensers. The station is conveniently situated on the banks of a canal from which water is taken for condensing purposes.

The cars are 22 feet long and will carry 40 passengers, mounted on bogie trucks, carrying two motors of 15 brake horse power running at 400 revolutions. They are series wound, and the gearing consists of double helical cast steel wheels having a radii of four to one. It is claimed that one of the motors is easily capable of taking a fully loaded car up the heaviest grade. The motors are in dust proof casings and are easily detached from the bogie.

There are two sets of brakes on each car, one applied to the inside edge and the other to the outside edge, being worked separately. There are four dry sand boxes, two at each end.

A complete set of switches is fitted at each end of the cars, and arranged so that either or both motors can be connected on the circuits. The speed of the motors is controlled by a multiple contact switch cutting resistance in or out of the motor circuit. The switching arrangements at each end of the car can only come into working on the interposition of a key, which is carried solely by the driver. Each car will be provided with a lightning arrester, and will be lighted by electricity. The car, when fully equipped, weighs about six tons, which is about ten tons less than the steam car.

Our contemporary concludes with the following remarks: "The performance marks an epoch in English overhead traction. Not only is it important as being the first line of any length to use the overhead system, but previous methods have been so much modified, that if success does attend the scheme, and we see little to doubt it, the overhead system ought speedily to meet with rapid development in England."

The Induction Motor: Who Invented It?*

BY RANKIN KENNEDY.

This question has been keenly discussed recently by Tesla, Stanley and Kelley in the New York electrical journals. In THE ELECTRICAL WORLD of Oct. 8 Mr. Tesla discusses the question of the relationship of the type of induction motor invented by myself and that invented by him, and with much skill makes out that my motor and his are similar in principle and action. Then in the same journal, October 22, Mr. Kelley claims for Mr. Stanley the invention of the motor which I describe as mine, and points out that the Tesla motor is quite a distinct type from that described by me.

Quite recently I gave my opinion regarding Tesla's claims in these columns, and I may here repeat that I am not at all concerned about the result of the contest over the claims to the invention. I may have been anticpated by Stanley and Tesla, but I contend that my motor is a distinct step in advance, and a very considerable improvement on the Tesla motor. I admit my motor springs directly from Tesla's, but in it some of the objectionable features of the Tesla motor are abolished and several quite novel features are introduced, so that although it may come under the broad

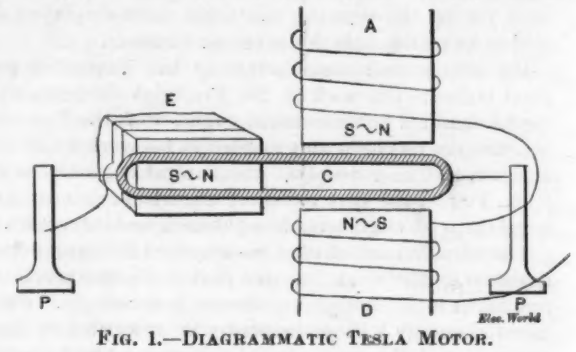


FIG. 1.—DIAGRAMMATIC TESLA MOTOR.

claims for an induction motor, it is none the less a step onward towards a perfect motor, and as such I claim the credit due it as its inventor.

The difference between the two motors under discussion somewhat resembles the difference between an open coil arc dynamo and a closed coil constant pressure dynamo; the fundamental prineiples of construction and action are the same in both, but the machines have many striking differences in their action.

To make the construction of the two motors clear, I have constructed two simple models illustrating a Tesla and a Kennedy induction motor, and showing their difference; diagrams of these models are here shown in Figs. 1 and 2.

In Fig. 1, *C* is a coil of copper closed in itself; either one turn or many turns may be used; it is pivoted on *P*, *P*, so as to turn freely on an axis. This coil lies between two field magnets at right angles to each other. *A*, *D* are the two poles of one of the magnets, and *E* is one of the poles of the other magnet, the opposite pole being removed to show the coil, *C*, in the position shown. It will be clear that the magnetic flux from the magnet, *E*, flows directly through the coil, while the flux from magnet *A* to *D* does not flow through the coil. It will now be plain that that part of the coil opposite *E* will act as a secondary generator, and a powerful current will be set up in the coil, which flowing round, acts as a motor current between the poles *A*. *D*. It will be seen that the position of the coil between the poles *A*, *D* is that in which it acts most powerfully as a motor. Now, as the coil moves on its axis through a quarter of a turn, that part of it between , *D* becomes the generator, and the part between magnet *E* becomes the motor, and so on the action goes producing a torque, which is not steady, but has four maxima and four minima in each revolu ion.

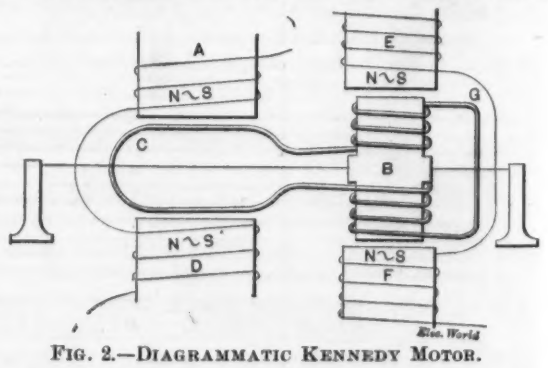


FIG. 2.—DIAGRAMMATIC KENNEDY MOTOR.

This is a Tesla motor. It requires two alternating currents in quadrature phase, one to excite the one field, and the other to excite the other field; quadrature phase is necessary, owing to the currents lagging behind the E. M. F. If the two exciting currents were in the same phase, then the current through the coil would not coincide with the magnetic maxima across the field, which, at that moment, was acting as the motor, and there would then be little or no torque; the maximum current in the coil must coincide with the maximum magnetic flux across the motor field; in other words, the phase of the *current* in the coil must be co-phasedly synchronous with the phase of the *magnetic flux* in the field acting as the motor at any moment.

If the various steps of induction are followed out, and their lag taken into account, it will be quite clear that quadrature exciting currents bring the current in the coil into phase with the magnetic flux in the motor field.

* From the *Electrical Review* (London).

This explanation says nothing about rotary poles. The author considers the rotary polar theory as a very pretty fiction upon which the action of induction motors was built up by mathematical processes.

Any theory which does not begin with and follow up the simple fact that in all motors the torque is due to a current in a coil placed in a magnetic field is a humbug. To analyze the action of any induction motor it is only necessary to trace the path of the magnetic fluxes and their relation to the coils carrying the induced currents; if this is done it will be found that they are acting as ordinary continuous motors do, and that there is no necessity whatever for any rotary polar theories to explain the torque.

One would have thought that the very idea of poles acting had been abandoned long ago when the idea of the closed magnetic circuit was adopted as the guide in all dynamo and motor designs. The rotary polar theory, as

FIG. 3.—KENNEDY INDUCTION MOTOR.

based on the action between magnetic poles, is, therefore, misleading, because all motor action in motors having ring and drum armatures is due to the forces acting on the current in the wires in the magnetic field; the poles govern only the direction of the forces, the magnetic flux and the current alone set up the forces. The models here described are easily made, and very nicely teach many lessons on induction.

The author's motor is shown in the diagram Fig. 2. Her again we have two fields, *A*, *D*, and *E*, *F*, excited by currents alternating in quadrature. Now, note difference between this and Tesla's motor; the coils in Tesla's motor act at one moment as a motor, at the next as a generator. In this motor the coil *C* acts continually as a motor coil; it forms part of a closed circuit with a coil *G*, which is wound on a laminated core *B*; this coil *G* acts continually as a generating coil, furnishing the current for the motor coil *C*. The generating part and the motor part are distinct and separate; the field *A*, *D*, and coil *C*, form a motor, while the field *E*, *F*, and coil *G*, form a secondary generator; *G* being the secondary to the primary wires on the magnet *E*, *F*. It will now be plainly seen wherein the difference of construction lies.

Now, for the difference in action; in the Tesla the same coils act alternately as motors and generators, and, as they are carried through the field, reactions take place which have never been, to my knowledge, made clear, but every one knows that counter E. M. F. is set up in a motor coil; in fact, besides the E. M. Fs. set up in the coils by the alternating magnetic fluxes there are E. M. Fs. set up by the motion of the coils in the field, and these very much complicate matters in the Tesla motor.

In the author's motor the generator part acts only as a secondary to the primary on the field *E*, *F*, the coils represented by *G* are in the actual machine wound on a laminated core having projecting teeth, as shown clearly in Figs. 3 and 4, reproduced here from page 661, May 27, 1892, of the *Electrical Review*, London. Now, such a core and coils revolving in a two pole field can have no E. M. F. set up due to the rotation in the field; the only E. M. Fs. set up in the

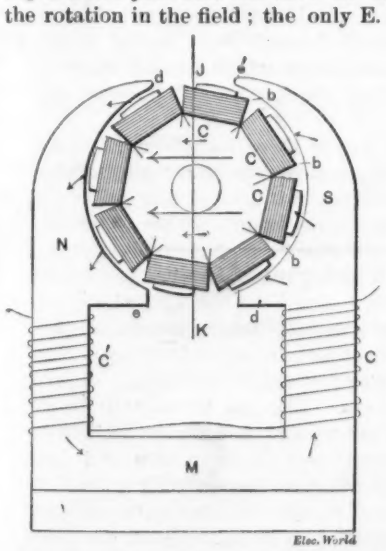


FIG. 4.—KENNEDY INDUCTION MOTOR.

coils are due to the magnetic flux. This very much simplifies matters, and is a very decided improvement on all other induction motors.

The induction motor is only in its infancy. As now made it is not yet fit for introduction into practical work. Some inventor must perfect the induction motor; but if he is not prepared to meet the charge of infringing Tesla's claims, he will have to keep his improvements to himself, as Mr. Tesla claims that his patent covers all induction motors. More's the pity.

The Budapest Electric Conduit Road.

There are about 50 cars in operation on the Budapest electric conduit road. The speed is ordinarily 9 miles an hour, but is not permitted to exceed 6 miles in the crowded streets, and is limited to 3½ at the junctions of the great avenues. It is run up to 10.8 miles in certain places. Each car makes from 70 to 90 miles in 16 hours' work.

The Ewing Magnetic Curve Tracer.

At a meeting of the Cavendish Physical Society, Cambridge, England, held recently, Prof. Ewing gave an exhibition of his magnetic curve tracer, using a form of the instrument which has just been constructed by Messrs. Nalder Bros. with the object of allowing the magnetic cycle to be performed at a high speed. Our readers will recall the description which we gave of this instrument in THE ELECTRICAL WORLD of August, at the time of its presentation to the British Association. Some additional information is here given, for which we are indebted to *The Electrician* (London).

The instrument is shown in Fig. 1. The magnetic circuit whose variations of magnetism are exhibited is arranged as a rectangle standing up from the base plate, and supported by a post in the centre. It is laminated, consisting of a number of strips of thin sheet iron, of the kind used in transformer cores. The ends of these are securely clamped in a pair of wrought iron pole pieces on the base plate, which is a slab of slate, and the poles have a narrow gap between them within which the stretched wire works which gives vertical motion to the mirror, proportional to the varying magnetism of the laminated circuit. A gun metal casting, arranged in the form of a bridge, supports the compound lever by which the pivot of the mirror is supported, as well as the springs which serve to keep the connecting threads taut; and the same bridge piece forms a post for the support of the main magnet, and also carries the other electromagnet, which consists of a piece of iron tube split longitudinally to form a slot for a second stretch wire, which gives horizontal deflection to the mirror, proportional to the magnetizing force. It will be remembered that this result is secured by keeping the magnetization of the tubular magnet constant, and by allowing the current which circulates in the magnetizing cell of the main magnet circuit to pass through the wire that is stretched in the slot of the tubular magnet. The pivot point of the mirror is held by a system of two adjusting levers which are moved by milled headed screws to give it two adjustments, vertical and horizontal, for the purpose of bringing the zero position of the spot of light to any desired point of the screen.

The mirror itself is pivoted in the manner shown in Fig. 2. The mirror *a* is cemented to a little cradle *b* of aluminium, in which a small hole or rather recess is drilled just behind the mirror. Into this recess a needle point, held by the fixed piece *c*, enters. At the other side of the cradle two threads are attached, of which one, *d*, goes down to the vertically moving wire in the gap of the variable magnetic circuit, and the other comes out, perpendicular to the plane of the paper, to the horizontally moving wire in the gap of the constant magnetic circuit. A pair of light spiral springs, of which one is indicated in the sketch at *e*, hold the threads taut, and are set to rake back a little, so that they give a component of force pressing the mirror cradle against its pivot sufficiently to prevent it from slipping off.

The magnetic cycle is performed in one-tenth of a second or less, but so smoothly that the mirror is at no stage subjected to any jerk. This requires that the variations of magnetizing current shall be continuous and gradual. An ordinary commutator with sudden makes and breaks of contact will not do, and the necessary smoothness is obtained by using a continuous commutator, the joint invention of Prof. Ewing and Mr. C. G. Lamb, which was described at the Cavendish Physical Society for the first time. The principle of the continuous commutator will be seen by reference to Fig. 3, which gives a sectional plan of the essential parts of the instrument. A cylindrical vessel of glass or earthenware, containing a solution of sulphate of zinc, has two zinc plates, *A* and *A'*, fixed in it at diametrically opposite portions of the inner circumference. These plates are connected respectively to the two poles of a battery. A boss of non-conducting material nearly fills the vessel, leaving only a narrow clearance space round it for the sulphate solution. The boss is supported on a

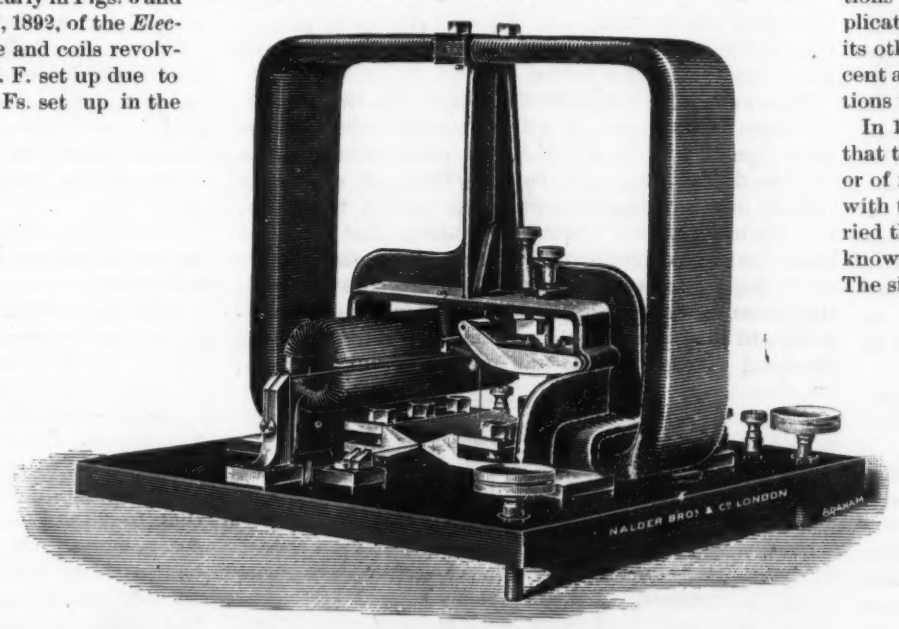
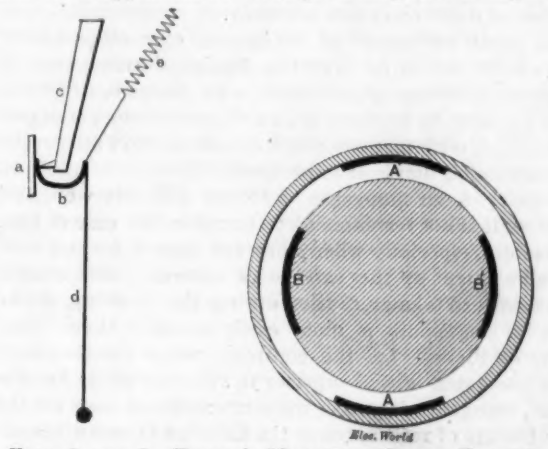


FIG. 1.—EWING'S MAGNETIC CURVE TRACER.

step, which allows it freedom to revolve, and is turned either by hand or by a pulley at the top connected with an electric motor. A second pair of zinc plates, *B* and *B'*, are fixed to the boss itself, on opposite sides of its circumference. As the boss revolves the plates fixed on it take a potential difference approximating to that of the fixed plates, as they pass these; then a quarter revolution brings the potential difference gradually to zero, the next quarter revolution raises it gradually to a value equal and opposite to the first, and so on. The plates carried by the boss are connecting to collecting rings on the vertical spindle, from which currents are led off through brushes it the magnetizing coil of the magnetic curve tracer. By having one of these continuous commutators placed in series with a fluid resistance slide, to superpose a continuous reduction of the strength of the current on periodic changes on its sign, the experiment was shown of "demagnetizing by reversals," in which the curve tracer exhibited the cyclic process gradually diminishing its range until the area of the diagram vanished.

The "Rayleigh" stage of the magnetization, when a feeble force applied or reversed gives magnetic changes in-



FIGS. 2 AND 3.—EWING'S MAGNETIC CURVE TRACER.

volving no hysteresis, was well shown in this way. A still more striking experiment consisted in placing two of the continuous fluid commutators in series, and turning one slowly or quickly by hand, while the other was left revolving uniformly at a high speed, when small loops appeared superposed on the principal cycle of magnetization.

The main magnet of the instrument, shown in Fig. 1, is wound with two magnetizing coils, which allow experiments to be readily made showing the influence exerted by a permanent magnetization of any assigned value on the behavior of the metal with respect to a supplementary force subject to cyclic variation, and on the amount of hysteresis which such a supplementary cycle involves.

"Manganin."

Experiments have been carried on for some time by various investigators to find a substance which had a constant coefficient of temperature, or, at least, one whose variations were so slight as not to interfere with its practical application to the manufacture of accurate resistances or for its other experimental purposes. Dr. St. Lindeck in a recent article in *L'Electricien* gives the results of investigations which he has made during the past few years.

In 1889 Mr. Edward Weston, of Newark, N. J., observed that the resistance of the alloys of manganese and copper, or of manganese, nickel and copper, did not change much with the temperature, but he does not appear to have carried these investigations to a practical end, and so far as known has not made any important use of his discovery. The simple addition of four per cent. of manganese to pure

"MANGANIN" RESISTANCE CURVE.

copper renders the value of the coefficient of temperature equal to that of "patent nickel," and if the proportion of manganese is raised to 10 per cent. the curve which represents the variation of resistance with temperature takes a very interesting form. In other words the specific resistance of the alloy increases with the amount of copper, and the resistance of an alloy composed of 30 per cent. manganese and 70 per cent. of copper exceeds 100 micro-ohms per centimetre. The alloy which possesses the most stability and which is best for practical purposes is, according to Dr. St. Lindeck, composed of 84 per cent. of copper, 12 per cent. of manganese and about 4 per cent. of nickel. This is known in commerce under the name of manganin. Its specific resistance is 42 micro-ohms per cubic centimetre.

The accompanying diagram, in which the abscissæ represent temperatures and the ordinates the resistance of a standard one-ohm coil, clearly shows the variations of the resistance of manganin with the temperature.

Between zero and 10° centigrade the coefficient of temperature has a value of .000025, but when the temperature increases this value diminishes, and between 20° and 40° is hardly appreciable. After having passed that point the resistance commences to diminish with the increase of temperature, that is, the coefficient of temperature becomes negative. We here find in the case of a metal properties which we have hitherto only encountered in electrolytes. It is seen from an inspection of this curve that the coefficient of temperature of manganin is so small that in all cases, except where the very highest precision is necessary, this metal can be considered as having no coefficient of temperature at all. In fact it is necessary to use very delicate apparatus in order to prove that the specific resistance actually does vary with the temperature.

In order to show that the resistance assumes always the same value at the same temperature, or, in other words, that there exists no hysteresis in the relation of the two values, Dr. St. Lindeck determined some of the points of the curve for ascending values and others for descending values of the temperatures, and repeated the experiment a number of times to ensure accuracy.

The great advantage of manganin over other known alloys is the fact of its very low thermo-electric power in the presence of copper, for while with German silver this value amounts to between 20 and 30 microvolts per degree centigrade, with manganin it is only from 1 to 2 microvolts a consideration that is of importance.

In the open air manganin does not act very well, and therefore it is not recommended for use in the case of bare conductors, especially when they are heated to any considerable extent by the passage of current. Moreover, it is necessary to take precaution during the drawing of the wire, for manganin is more easily oxidized than either copper or nickel. On the contrary, when covered with silk a manganin wire is superior to all other alloys known in fact, manganin is almost without exception used for the manufacture of resistances in the different German laboratories. The fact that the maximum resistance of manganin is not far from the average temperature of the laboratory has led to its commercial production. Its resistance has also been found to be remarkably constant, and experiments extending over a period of several years show that the greatest changes in the resistance in a period of one year did not exceed .005 per cent.

A Universal Transformer.

BY GIULIO M. APPOLONJ.

The apparatus about to be described is of three different types, according as we require to :

1st. Transform a continuous into a continuous current.

2d. A simple alternating current into a continuous one, or vice versa.

3d. A polyphase alternating current into a continuous one, or vice versa.

The first of these types, which transforms a continuous current at a low or high potential into a continuous current at a high or low potential, is represented in Fig. 1. It consists of a laminated iron ring, composed of ring shaped plates one over the other. Along the centre line of this ring a number of rectangular apertures are symmetrically cut in such a way that by passing two different conductors through them two bobbins can be formed—one embracing one of the sides of the apertures and the inner face of the ring, and the other the opposite side of the aperture and the outer face of the ring—so that there are, therefore, as many couples of bobbins as there are apertures in the ring. By uniting the internal bobbins to the sections of a collector, a Pacinotti armature is obtained ; and by uniting the external bobbins to a similar external collector, as shown in Fig. 1, a second Pacinotti ring is obtained, rigidly joined to the first.

Two brushes are then put in contact with the internal collector, and two with the external one, taking care that all the contacts are on the same diameter of the ring.

If a continuous current is sent through one of the pairs of brushes, say through the external, a pair of magnetic poles will be formed in the ring ; if now a rotating movement be given to the brushes, these two poles will follow that movement with the same velocity and in the same direction. An induced current will therefore be developed in the internal winding, which will be carried off through the internal brushes in the form of a continuous current, provided they move in the same direction and with the same velocity as those for the external winding. It is sufficient, therefore, to unite rigidly the two pairs of brushes and put them in motion, in order that the current sent into two of them may be returned by the other two. It is clear that if the bobbins of the two armatures have the same number of turns of wire the difference of potential at each pair of brushes will be the same. But if this number varies the difference of potential will vary in the same proportion. We shall therefore be able to obtain a real transformation of current from a high to a low potential, while the current produced in the apparatus will remain continuous.

The second type of apparatus, shown in Fig. 2, is intended to transform a continuous current into an alternating one at a low or high potential, and is composed of a laminated iron ring, identical with the one already described. In this apparatus, however, it is only the winding which, in Fig. 2, is in the interior, which constitutes a Pacinotti armature ; the other winding, placed outside, has all the bobbins disposed in series, and is without collector or brushes. In this arrangement the internal Pacinotti armature is of four poles, and the continuous external conductor is wound in such a way as to form the four poles corresponding to those produced internally when the current is introduced. Let us suppose that a continuous current is sent into the apparatus through the brushes. In the external conductor, which we will suppose closed on a resistance, a feeble induced current will be developed, which will last only for the short

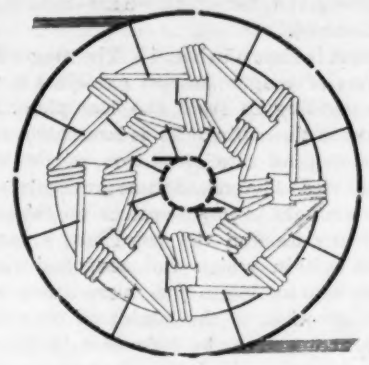


Fig. 1.

time required to establish the regular flow of the current developed in the other winding. If, on the other hand, the brushes which conduct the current are made to revolve in a continuous manner, a flow of magnetic force will be produced which will rotate in the iron of the ring simultaneously. This rotating flow will produce, in its turn, an alternating current in the external conductor, which will have two N alternations per unit if the brushes make N revolutions in the same time. We shall thus obtain the transformation of a continuous current into a simple alternating one at a more or less elevated potential, according to the proportion that exists between the number of turns of the two windings.

As this apparatus is reversible it follows that by sending an alternating current into the external conductor and causing the brushes in the armature to move synchronously with the alternations of the current, these will give a continuous current at the potential which is determined by the

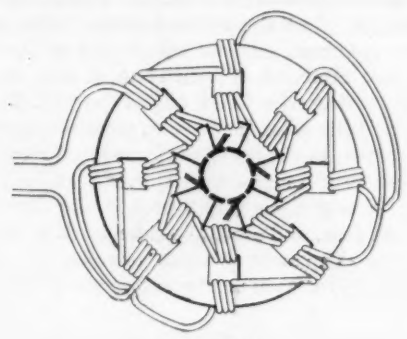


Fig. 2.

proportion referred to above. We shall therefore have a true redressing of the current with an accompanying transformation in its potential.

After examining the mode of action of the two preceding types of apparatus, it will be easy to understand the third type represented in Fig. 3. In this we have the same laminated iron ring with two windings, of which the interior one forms a Pacinotti armature with two poles, and the exterior one, which is continuous and closed on itself, has three wires attached to it at an angular distance of 120 degrees from each other. If a continuous current is sent through the revolving brushes three alternating currents will be produced in the outside coils, which will be displaced in their phases by 120 degrees, and vice versa,

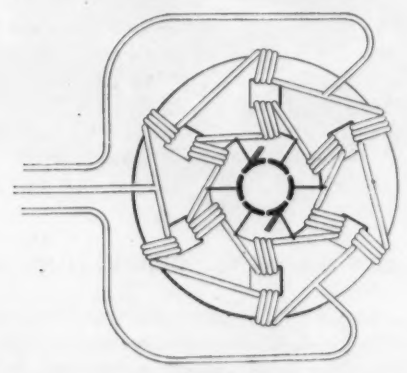


Fig. 3.

if through the three derivations alternating currents are sent displaced from each other by 120 degrees, and the brushes are made to revolve synchronously with the field produced by the currents, a continuous current will be obtained from them.

The principle of reversibility of every apparatus of this kind would be sufficient in itself to assure us of this transformation coupled with a straightening or redressing of the current, but it can also be demonstrated in the following manner :

Let us first state that the external winding, shown in Fig. 3, is the one known as the closed circuit, but it could also have been connected in open circuit, and the effect would be the same.

Let us suppose that the intensities of the currents sent through the conductors are expressed by the equations :

$$1 = I \sin \frac{2\pi t}{T}$$

$$1_2 = I \sin \left(\frac{2\pi t}{T} - 120^\circ\right)$$

$$1_3 = I \sin \left(\frac{2\pi t}{T} - 240^\circ\right)$$

The equations which represent the intensity of the currents circulating in the internal winding of the apparatus will be :

$$i' = I \sin \frac{2\pi t}{T}$$

$$i'' = I \sin \left(\frac{2\pi t}{T} - 120^\circ\right)$$

$$i''' = I \sin \left(\frac{2\pi t}{T} - 240^\circ\right)$$

with the proportion

$$I = 1.732\, I$$

In the latter set of equations assigning to t particular values, for instance, $t = 0$, $t = \frac{1}{3} T$, $t = \frac{2}{3} T$, we obtain the following :

$t = 0$	$i' = 0$	$i'' = I_1 \sqrt{\frac{3}{2}}$	$i''' = I_1 \sqrt{\frac{3}{2}}$
$t = \frac{1}{3} T$	$i' = I_1 \sqrt{\frac{3}{2}}$	$i'' = 0$	$i''' = I_1 \sqrt{\frac{3}{2}}$
$t = \frac{2}{3} T$	$i' = I_1 \sqrt{\frac{3}{2}}$	$i'' = I_1 \sqrt{\frac{3}{2}}$	$i''' = 0$

That is to say, we shall have a magnetic field, which, revolving continually in the iron core of the apparatus, produces induced currents in the connected Pacinotti armature in such a way that a continuous current will be gathered from its brushes if they revolve with the same velocity as the magnetic field.

We may therefore conclude that by means of the three types of apparatus proposed it is possible to obtain any transformation of current coupled with redressing ; a continuous current, while remaining continuous, can be transformed into another of different potential; an alternating current can be transformed into a continuous one at any potential required; a continuous current can be transformed into an alternating one, either simple or polyphase, according as one apparatus or another is used.

The advantages of this general transformation are obvious; we wish, however, to point out the properties which more particularly characterize each of the three types proposed.

The first type has two very essential peculiarities. *First*, it has no heavy pieces in motion, and the crusher can be moved by an almost insignificantly small fraction of a horse power. *Second*, it is not costly. It is especially suited for the charging of accumulators in the transmission of energy to a distance made with continuous currents and to distribution in series.

The second type is adapted more especially to suit all plants, existing and future, based on the use of alternating currents, for electric traction. So far no electric railway is known which is run by alternating currents, as synchronous alternating currents (which are applicable with difficulty even for stationary purposes), are quite impracticable as traction motors. With this apparatus, however, it becomes possible, because it allows of the redressing of an alternating current from the generating station, accompanied by a transformation to a lower voltage.

In the case of long railways the redressing ought to be done on the locomotives, while in the case of tramways and secondary railways it would be more convenient to send the alternating current along the lines, and at certain distances place the transformers which should feed the conductors for distributing the continuous current to the cars.

In the transmission of power these transformers permit the use of continuous current motors on alternating current circuits.

Rome, October, 1892.

The New Westinghouse Lamp.

The Westinghouse Electric and Manufacturing Company has announced the prices of its new separable lamps. The manufacture, sale and use of which, it is claimed, do not infringe the Edison patents. The list prices will be 35 cents for 25 and 20-c. p. lamps, and 30 cents for 16, 10 and 8-c. p. lamps. The discount will be from two and one-half to ten per cent., according to the quantity ordered at one time, and ten per cent. regularly to its central stations. The allowance for the delivery at its factories of the glass parts of such lamps will be ten cents each, so that the net price of the 16, 10 and 8-c. p. lamps, which form nine-tenths of those used, will be 17 cents each. The net price for 20 and 25-c. p. lamps will be 21½ cents. The efficiency of the 50-volt lamps is placed as high as 2½ watts per candle power. It is claimed that the saving to a central station by the return of the glass parts of the lamps and the low prices of the new lamp will equal nearly one per cent. dividend on its capital stock.

A High Tension Transmission of Power Plant.

A contract has just been made in Switzerland for an installation in which 365 h. p. is to be transmitted to a distance of about 17 miles with a guaranteed efficiency of 70 per cent. by means of a direct current. The generator is to be driven by two turbines coupled direct to two Thury dynamos by means of an elastic coupling, the speed being 275 revolutions. The voltage is to be 3,400. Presumably the two dynamos are to be coupled in series,

Test of an Improved Parsons Condensing Steam Turbine.

About a year ago Prof. J. A. Ewing made some tests of the Parsons steam turbine, of which we published a report in THE ELECTRICAL WORLD of Jan. 30, 1892. The results of this test showed a consumption of 37, 39 and 43 pounds of steam per kilowatt hour at full load, at half load and at one-third load respectively. Since that time improvements have been made which now bring it up to a par with the usual steam engines as regards efficiency, and, according to Prof. Ewing, this engine is now eminently well fitted for central station use. Prof. Ewing's report on a recent test made with the present improved form will be found in full in *Industries* (London), Nov. 11 and 18, from which we take the accompanying illustrations. The following abstract contains the full description of the engine, the results of the test, and most of the conclusions; only the details of the test have been omitted.

The object of the present series of trials was to see how far the efficiency has been improved by certain recen changes and by the use of superheated steam. The same turbine was used in these as in the former trials, but some additional rings of turbine blades were inserted at the high pressure end to enable it to deal more effectively with pressures up to 115 pounds per square inch (absolute), the vacuum was improved by the use of a larger air pump and by admitting the injection water at a point of the exhaust pipe closer to the turbine, and there was a new governor. The chief factor in the improvement which has now been brought about is, however, the use of moderately superheated steam.

The improvement demonstrated by these new trials is very marked. Thus, in the present turbine, with steam superheated 60 degrees Fahr. above the temperature of saturation, the gross amount of feed water is 28.4 pounds per electrical unit generated when the machine is working at full load, and 32 pounds per unit at half load. By carrying the superheating further—to 123 degrees Fahr. above saturation—the consumption at full load is reduced to 27 pounds per electrical unit. Comparing these figures with those of the former trial, it will be seen that the consumption of steam has been reduced by about 27 per cent. What makes these results specially important is the consideration that there is nothing in the construction or working of the turbine to make it likely that the use of superheated steam will be attended by any drawbacks such as have been experienced in engines of the ordinary type. The steam works without lubrication, it comes into contact with no rubbing surfaces, and there is no packing to be injured.

The plant tested is illustrated in elevation in Fig. 1 and in general plan in Fig. 2. The turbine case *A A* contains a series of seven revolving discs, from the surface of which the turbine blades project. They are arranged on each disc in a series of concentric rings. The fixed guide blades stand in spaces between these rings, being carried by annular discs which are fixed to the case. Thus each revolving disc, with its neighboring fixed disc, forms a series of outward flow turbines, the steam entering the series inside the smallest ring of blades and escaping at the circumference into a channel, which conducts it between the back of the revolving disc and of the next fixed disc to the inside of the next series of rings. The arrangement will be understood by reference to Fig. 3, which is a section showing the first three turbine discs. The heights and apertures of the turbine blades on each disc are adapted to the increasing volume of the steam as it expands from an absolute pressure of 115 pounds per square inch to an absolute pressure of 1 pound per square inch. The first six discs, which are each 15 inches in diameter, are designed to expand the steam to about atmospheric pressure, the remainder of the expansion being performed in passing the seventh disc, which is 26¾ inches diameter, and has (unlike the other six) a double series of rings of blades, one series on each side, through which the steam flows "in parallel." The height to which the turbine blades project above the discs in which they are secured varies from $\frac{3}{16}$ inch to 1 inch. The total number of rings of moving blades in the machine tested was 35. The blades are made of strong sheet brass, and show no sign of wear after continued use. Steam enters the turbine case at one end through a double beat valve shown in Fig. 3, and after passing the successive turbine discs is discharged at *B* (Fig. 1) to a condenser. The longitudinal pressure on the turbine shaft, due to the one-sided character of the six smaller turbine discs, is balanced at the high pressure end by a revolving baffle piston (Fig. 3), with a number of deep grooves on its circumference, which are entered by corresponding projections on a fixed bush resembling a thrust block. Any small amount of longitudinal thrust which may remain unbalanced is received by an adjustable grooved thrust bearing at the end of the spindle beyond the main bearing. This bearing is contained in the oil box *C* (Fig. 3). The thrust bearing consists of seven collars on the spindle revolving in a grooved bush, which is split longitudinally into halves with separate longitudinal adjustment to allow any wear to be taken up, so that end shake is prevented, and the endwise position of the shaft is maintained with great precision. This device also gives a means of regulating the amount of clearance over the tips of the turbine blades. The thrust bearing, like the main bearing, runs in a bath of oil.

The main bearings are of a special construction which is admirably adapted to insure easy running at a high speed and to damp out vibration. The shaft (Fig. 4) rotates in a phosphor bronze sleeve, outside of which are slipped three concentric steel tubes fitting loosely over one another. The outermost tube is a loose fit in the casting which forms the seat of the bearing. Oil is continuously and freely fed to the bearing from a cistern above, under a head of some six inches, and drains into a chamber below, from which it is automatically pumped back to the cistern. The oil is used over and over again. In this way the small clearance between each tube or sleeve and the one outside of it are kept charged with a film of oil, with the effect that while the shaft retains a necessary small amount of freedom to adjust itself by lateral displacement, the viscosity of the films acts as a powerful damper to prevent oscillation from being set up. The working of the bearing is perfectly satisfactory, and the damping action is so great that the shaft may even be put considerably out of balance without causing the vibration to become excessive or making the bearings run hot. In the ordinary conditions of balance the shaft carrying the turbines, the main armature and the exciter armature runs at 80 revolutions per second with a steadiness and quietness which are very remarkable.

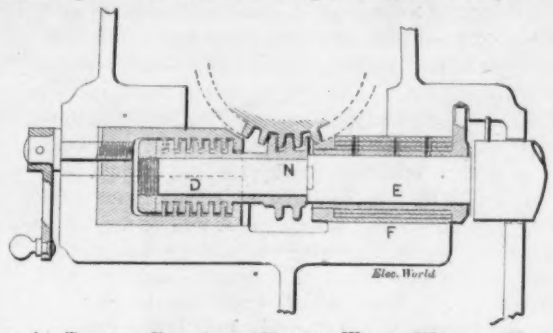
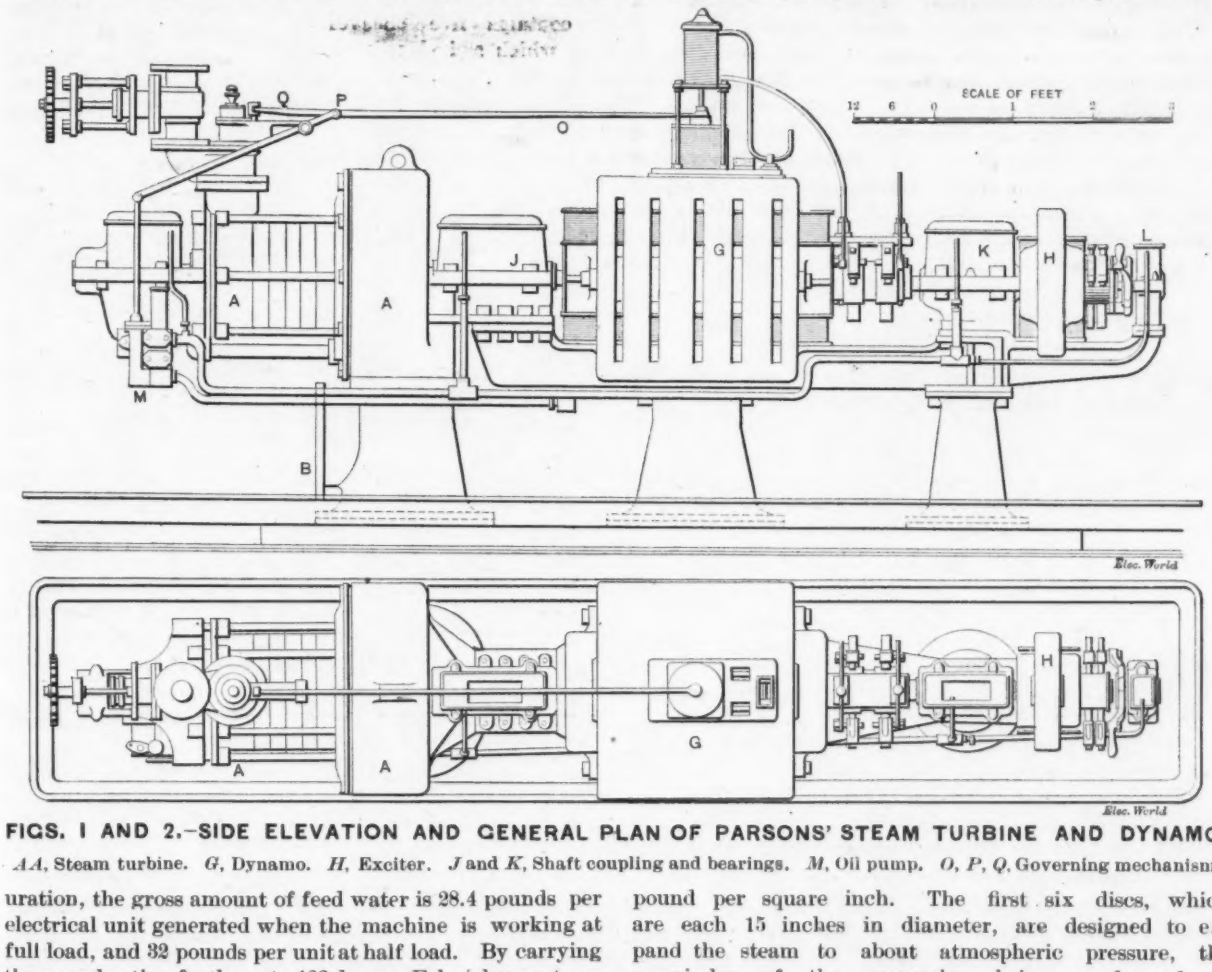


FIG. 4.—THRUST BEARING (*D*) AND WORM WHEEL (*N*) FOR DRIVING THE ECCENTRIC WHICH OPERATES THE OIL PUMP AND THE REGULATOR.

The shaft passes out of the turbine case at each end through a lantern brass or steam gland. The whole shaft is in three lengths; the first part carries the turbines, the second carries the armature of the main dynamo *G* (Fig. 1), and the third part that of the exciter dynamo *H*. The parts are coupled by means of a square bored sleeve slipped over squared ends. The couplings are placed in the middle of ong double bearings at *J* and *K*. These, as well as the end bearing at *L*, are all formed by concentric tubes, and work drowned in a sea of oil, as already described for the end bearing. The oil chambers are connected by pipes, so that a single oil pump maintains the circulation in all. The pump, which is shown at *M* in Fig. 1, is driven by an eccentric which in turn receives motion from a worm *N* on the main shaft, working in oil, between the main bearing and thrust bearing of Fig. 4.

The governing of the machine tested was accomplished by a novel and extremely effective appliance. Steam was admitted to the turbine in a series of gusts by the periodic opening and closing of the double beat lift valve shown in Fig. 3. This valve was operated by means of a steam relay in mechanical connection with the turbine shaft, so that the valve was opened regularly once in every 28 revolutions of the shaft. The duration of each gust was controlled by an electric solenoid, which was connected as a shunt to the field magnets, but was compounded so as to keep the volts constant. The core of the solenoid was hung from the end of a long lever *O* (Fig. 1). The fulcrum *P* of this lever was periodically moved up and down by means of a link connecting it with the eccentric which also served to drive the oil pump. The short end of the lever *Q* controlled the valve of the steam relay. Each periodic movement caused a gust of steam to be admitted to the turbine, the duration of the gust depending on the height of the distant end of the lever. The effect was that at full load the gusts became blended into an almost continuous blast, the lift valve closing only momentarily, or not at all, in each of the periodic movements; under any lighter load each interval of admission alternated with an interval during which the steam was completely shut off. The action of the governor was most satisfactory. The periods of admission were so frequent that they caused no material throbbing of speed nor any variations of volts sensible on a voltmeter. There was no hunting, and the freedom from friction was greater than the experimenter had seen in any governor. He repeatedly threw the whole load, amounting to over 130 electrical horse power, on and off suddenly, without causing more than a momentary variation in the volts. The governor was sensitive, quick and certain in its action to quite an exceptional degree.



FIGS. 1 AND 2.—SIDE ELEVATION AND GENERAL PLAN OF PARSONS' STEAM TURBINE AND DYNAMO.

A A, Steam turbine. *G*, Dynamo. *H*, Exciter. *J* and *K*, Shaft coupling and bearings. *M*, Oil pump. *O*, *P*, *Q*, Governing mechanism.

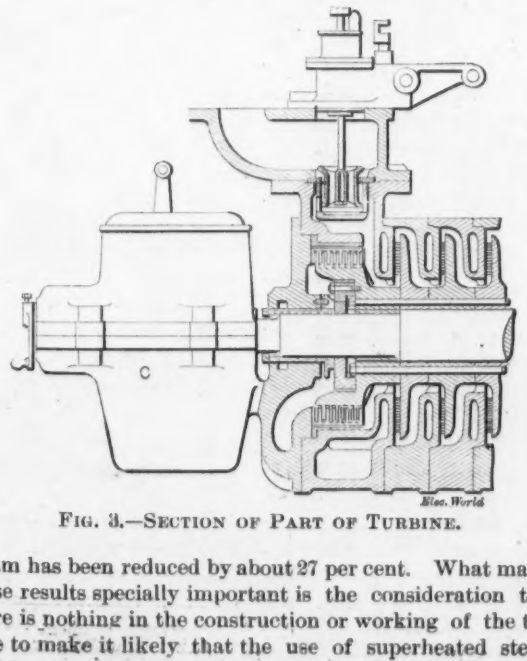
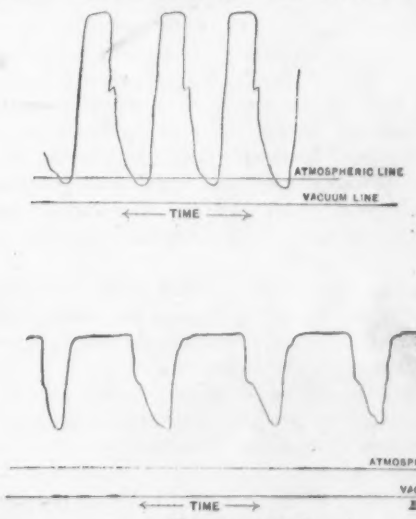


FIG. 3.—SECTION OF PART OF TURBINE.



FIGS. 5 AND 6.

By applying an indicator at the admission end of the turbine chamber, below the double beat valve, observation was made of the pressure during the periodic admission of steam; this was done by pulling the paper drum of the indicator as steadily round as possible by hand while the pencil rose and fell. Figs. 5 and 6 are examples of diagrams obtained in this way. In Fig. 5 the load was about one-half the maximum; in Fig. 6 it was about three-quarters. The pressure which these diagrams show during admission is about four pounds less than that shown at the same

time by a pressure gauge on the steam pipe above the governor valve.

The machine was tested with an alternating current dynamo of 50 ampères and 2,000 volts, and also with a continuous current dynamo of 400 ampères and 250 volts, in which case the exciter was used, as before, to excite the field. The armature was 2 feet 6 inches long and 9 inches in diameter; the weight of copper on it was only 33 pounds, or one-third of a pound per kilowatt.

The results of the tests are shown by the curves in Figs. 7 and 8, and the data accompanying them.

To facilitate comparison, the amount of feed water used per electrical unit at various rates of output, as measured from the curves of Fig. 8, is given numerically in the following table:

CONSUMPTION OF FEED WATER AT VARIOUS OUTPUTS WITH SUPERHEATING.

Rate of output in electrical units per hour.	Feed water per electrical unit. With superheating to about 400° Fahr.	Feed water per electrical unit. With extra superheating to 465° Fahr.
20	48	
30	39	36½
40	34½	32
50	32	29½
60	30½	28½
70	29½	28
80	29	27½
90	28½	(27)
100	28½	(27)

The trials show that a very considerable advantage is realized by moderate superheating. To superheat the steam from, say, 338° Fahr., the temperature of saturation for a boiler pressure of 100 pounds to 400° Fahr. requires the addition of barely 30 units of heat, which is less than three per cent of the heat taken up in the boiler. With steam superheated to this extent the consumption of full loads is less by one-fourth than the consumption in the old trials. How much of this increase in economy is due to superheating alone cannot well be distinguished without further trials, as the comparison is complicated by the other improvements referred to at the beginning of this report. It is clear, however, that superheating is responsible for a great part of the difference.

The further advantage realized by superheating to 465° Fahr. is comparatively small, especially at high loads.

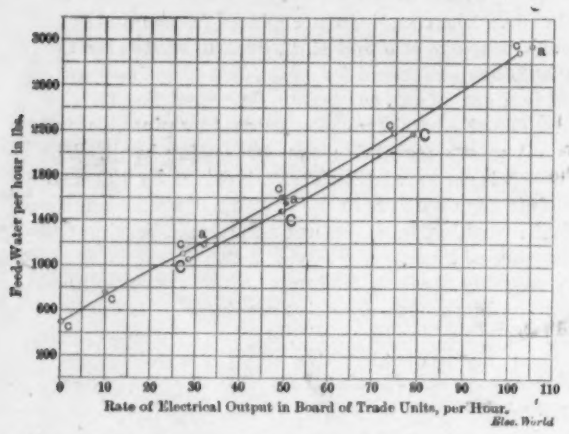
It may be concluded from certain considerations as well as from the results of the trials, that very little increase of efficiency is to be brought about by carrying the superheating further than 443° Fahr. It seems, therefore, undesirable to push the superheating to a higher point than can readily be reached by the use of a superheater in the boiler flue. With a superheater of moderate size the hot gases of the uptake will furnish as much superheating as need be aimed at, and as much as is sufficient to secure highly economical working.

The general result of the trials is to demonstrate that the condensing steam turbine is an exceptionally economical steam engine. The application to it of moderately superheated steam has put the performance of the turbine on a level with that of the best steam engines of the ordinary type. A consumption of 27 pounds or 28 pounds of steam per electrical unit at full load, and 30 pounds or 32 pounds at half load, is a result that does not need to have its significance emphasized. The efficiency under comparatively small fractions of the full load is probably greater than in any steam engine, and is a feature of special interest in relation to the use of the turbine in electric lighting from central stations.

The consumption of 28 pounds per unit corresponds to 20.9 pounds per electrical horse power hour. To facilitate comparison with other engine trials, it may be useful to estimate from these results what may, by analogy, be called the "indicated" horse power of the turbine—that is to say, the mechanical work done by the steam on the turbine blades. The curves of Fig. 7 are nearly straight lines, and by prolonging them backward to meet the base line produced, it appears that the *idle work*—that is to say, the work done without useful output—was equivalent to 27 kilowatts, or 36 h. p. The effective work done at full load, the equivalent of 100 electrical units per hour, was 134 electrical horse power. Hence, if the idle work had the same value at full load as when the machine was running light, the total work done by the steam at full load would be 170 h. p. and the effective work (134 h. p.) would be 79 per cent. of the total. But the idle work certainly increased when the machine was loaded, and it will be nearer the truth to assume that the effective work was not more than 75 per cent. of the total work. This would make the total work about 179 h. p. On this basis a consumption of steam at the rate of 28 pounds per electrical unit is equivalent to 15.7 pounds of feed water per indicated horse power hour, and 27 lbs. per unit is equivalent to 15 1 pounds per indicated horse power hour. Similarly, the consumption of half load is equivalent to about 17 pounds per indicated horse power hour.

If, in addition, proper allowance is made for leakage of steam and water from the boiler, the results would be even more favorable; this, he estimates, would reduce the steam consumption about 3 per cent. for full power and 6 per cent. for half power. A further detailed test showed that the proportions were not the best, a correction of which in future machines would, he thinks, secure even better results.

In concluding his report Prof. Ewing says: "Apart from the other possible applications of a peculiarly light and efficient high speed motor, the turbine dynamo in its present state is, in my opinion, eminently well fitted for central station use, not only on account of its economy of steam under both heavy and light loads, but also on account of its exceptional lightness and compactness, its small first cost, its independence of foundations, its freedom from vibration, its steady governing, its simplicity, the ease with which it is handled, and the moderate outlay which it may be expected to require under the heads of maintenance, oil and attendance. So far as I have been able to judge, the performance of the machine is as excellent as its details are ingenious."


Feed-Water per hour in lbs.
Rate of Electrical Output in Board of Trade Units, per Hour.
Elec. World
Feed-Water used per Electrical Unit generated.
Rate of Electrical Output in Board of Trade Units, per Hour.
Elec. World

FIGS. 7 AND 8.—STEAM TURBINE CURVES.

Observations: *ccc* with continuous currents and moderate superheating: boiler pressure, about 100 lbs.; temperature, about 400° F.; superheating, about 60° F.; speed, 4,501 rev. per min.
aaaa, ditto with alternating currents.
CCC with continuous currents and extra superheating: boiler pressure, about 102 lbs.; temperature, about 465° F.
In all the trials the output does not include that of the exciter.

Performance of an Overhead Traveling Crane. Operated by a Single Electric Motor.*

BY ANTHONY VICTORIN.

The accompanying table contains data relative to the performance of an overhead traveling crane at the army gun factory, Watervliet Arsenal, West Troy, N. Y. The crane is operated by a single (flat field) electric motor. The electric current is generated by a Thomson-Houston 65 h. p. dynamo. Its voltage is 500, the speed 1,020 revolutions per minute. The crane has a span of 60 feet, a clear hoist of 40 feet, and a capacity of 120 gross tons. The capacity of the auxiliary hoist is 10 tons, hoist 56 feet. The total weight of the crane is about 150 tons. The bridge rests on eight double flanged wheels (four on each side) of 36 inches diameter, the trolley on sixteen wheels of 24 inches diameter. All wheels are arranged in pairs in compensating beams to avoid inconvenient results from want of uniformity in the level of the track rails. All wheels have also anti-friction steel roller bearings.

The motor is located at one end of the bridge. It receives the electric current through a bare copper wire, which is strung on insulated rollers along the crane ways. The motor is in permanent gear with the clutch shaft. This shaft is fitted with four clutch gears.

Two square driving shafts are located on the bridge, one on each side. The first operates by means of clutches the bridge travel and trolley travel and the auxiliary hoist; while the second operates similarly the main hoist only.

The crane performs the following operations:

Bridge travel = 40 and 80 feet per minute.
Trolley travel = 50 and 100 feet per minute.
Main hoist = 2, 4, 8 and 16 feet per minute
Auxiliary hoist = 20 and 40 feet per minute.

Automatic brakes are provided to sustain the load in any position.

The trolley is provided with two grooved chain drums, each being capable of winding 250 feet of 1¼-inch wrought iron main hoisting chain. These chain-drums revolve loose on trolley axle shafts 7 inches in diameter, with bronze bushed bearings of 24 inches length at each end of drums. The lower chain sheave block contains six bronze bushed sheaves of 30 inches diameter, while the upper block contains five sheaves of 33 inches diameter, each of which swivels independently of the others. The chain is rove twelve times through the sheaves. The chain drum of the auxiliary hoist is located above one of the main chain drums, and is grooved for a ⅝-inch chain of sufficient length for 56 feet hoist.

The operating cage contains all manipulating levers, also the main switch, rheostat, etc. All motions of the crane can be in operation simultaneously. All gears of the crane mechanism are carefully cut, except the gears on the chain drums, which are cast; all bearings have bronze bushings, all working surfaces are finished smoothly and all parts are carefully adjusted.

But notwithstanding all possible care with respect to the construction and the arrangement of the crane mechanism, a great percentage of the driving power is absorbed by friction—as indicated in the last column of the performance table—and the maximum efficiency of the main hoist is only about 40 per cent. The lowest efficiency is about 20 per cent.

It may reasonably be assumed that the friction in the mechanism for the bridge travel and the trolley travel at-

* A paper read at the New York meeting of the American Society of Mechanical Engineers.

Operation.—Voltage, 500.			Test of June 8, 1892. Amperes.	Test of June 8, 1892. E. H. P. at 500 volts.	Test of October 8, 1892. Amperes	Test of October 8, 1892. E. H. P. at 500 volts.	Maximum amperage observed in starting. June.	Maximum amperage observed in starting. Oct.	Load.	Theoretical H. P.	Efficiency.*
Motor and clutch gears			5	3.35	5	3.35	..	..		.....	.....
Square shaf for main hoist			9	6.03	7	4.69	..	..		.....	.....
Square shaft for bridge and trolley travel			10	6.70	7	4.69	..	..		.....	.....
Both square shafts			16	10.72	13	8.81	..	..		.....	.....
Bridge travel	40 ft. p. M.		15	10.05	15	10.05	..	25		.....	.....
" "	80 "		24	16.08	25	16.75	..	45		.....	.....
Trolley travel	50 "		15	10 05	12	8.04	..	15		.....	.....
" "	100 "		23	15.41	22	14.74	..	33		.....	.....
Main hoist	2 "	hoist	15	10.05	15	10.05	..	18		...	.....
		lower	10	6.70	5	3.35	..	18		.....	.....
" "	4 "	hoist	22	14.74	23	15.41	.	50		.....	.....
		lower	14	9.38	10	6.70	.	48		.....	.....
" "	8 "	hoist	29	19.43	32	21.44	55	60		.....	.....
		lower	12	8.04	7	4.69	35	45		.....	.....
Auxiliary hoist	20 "	hoist	13	8.81	13	8.81	18	..		.....	.....
		lower	11	7.37	10	6.70	..			.....	.....
" "	40 "	hoist	20	13.40	23	15.41	35	..		.....	.....
		lower	16	10.72	17	4.69	30	..		.....	.....
Bridge travel	40 "										
Trolley "	50 "										
Bridge "	80 "										
Trolley "	100 "		21	14.07	20	13.40	..	42		.....	.....
Bridge "	40 "										
Trolley "	50 "										
Main hoist	2 "	hoist	30	20.10	30	20.10	..	55		.....	.....
		lower	27	18.09	28	18.76	..	40		.....	.....
Bridge travel	80 "		21	14.07	20	13.40	..	42		.....	.....
Trolley "	100 "										
Main hoist	8 "	lower	21	14.97	20	13.40	..	..		.....	.....
Bridge travel	40 "										
Trolley "	80 "										
Main hoist	8 "	hoist	54	36.18	60	40.20	..	80		.....	.....
Bridge travel	40 "	lower	30	20.10	30	20.10	..	..		.....	.....
" "	80 "		20	13.40	17	11.39	..	30		.....	.....
Trolley "	50 "		32	21.44	30	20.10	..	55		.....	.....
" "	100 "		15	10.05	15	10.05	..	30		.....	.....
			30	20.10	25	16.75	..	40		.....	.....
Main hoist	2 "	hoist	30	20.10	32	21.44	..	60		4.07	19%
		lower	4	2.68	2	1.34	..	..		.....	.....
" "	4 "	hoist	53	35.51	53	35.51	..	80		8.14	22.9%
		lower	0	0	0	0	..	45		.....	.....
" "	8 "	hoist	70	46.90	75	50.25	..	110		16.29	32.4%
		lower	0	0	0	0	..	45		.....	.....
Bridge travel	40 "		22	14.74	20	13.40	..	30		.....	.....
" "	80 "		30	20.10	30	20.10	..	65		.....	.....
Trolley "	50 "		17	11.39	15	10.05	..	23		.....	.....
" "	100 "		28	18.76	25	16.75	..	65		.....	.....
Main hoist	2 "	hoist	38	25.46	37	24.79	..	55		8.14	32.9%
		lower	0	0	0	0	..	30		.....	.....
" "	4 "	hoist	65	43.55	70	46.92	..	70		16.29	34.7%
		lower	0	0	0	0	..	60		.....	.....
" "	8 "	hoist	..	.....	120	80.40	..	..		32.58	40.5%
		lower	..	.....	0	0	..	..		.....	.....
Bridge travel	40 "		20	13.40	22	14.74	..	42		.....	.....
" "	80 "		40	26.80	45	30.15	..	70		.....	.....
Trolley "	50 "		20	13.40	22	14.74	..	35		.....	.....
" "	100 "		45	30.15	40	26.80	..	65		.....	.....
Main hoist	2 "	hoist	80	53.60	75	50.27	..	110		16 29	32.4%
		lower	0	0	0	0	..	45		... ..	.....
Auxiliary hoist	20 "		37	24.79	35	23.45	..	..	10 gross tons.	13.58	57.9%
" "	40 "		47	31.49	45	30.15	..	..	5 gross tons.	13.58	45%

No load. 30 gross tons. 60 gross tons. 120 gross tons.

* This efficiency refers to that part of the electrical circuit at which the voltage was 500. Whether this was the voltage at the motor, the dynamo, or merely that engraved on the name plate of the generator, is unfortunately not stated.—EDITORS ELECTRICAL WORLD.

tains similar proportions, as given for the hoist; and that the efficiency ranges from about 25 per cent. for the slowest speeds, with the greatest number of gear trains in operation, to about 50 per cent. for the highest parts, with fewer speeds in operation.

The figures in the table permit various calculations as to the frictional resistance in certain parts of the crane, *i. e.*:

Theoretical work of hoisting 120 gross tons 2 ft per min.....	= 16.3	h. p.	= 24.3 ampères.*
Actual† work of hoisting 120 gross tons 2 ft. per min.....	= 50.27	"	= 75 "
Frictional resistance in crane.....	= 33.97	h. p.	= 50.7 ampères.
Actual work of operating hoist 2 ft. per min. without load.....	= 10.05	"	= 15 "
Frictional resistance due to the load of 120 tons.....	= 23.92	h. p.	= 35.7 ampères.

It was observed that the power required to bring the crane mechanism up to speed from the state of rest is considerable, and is from about 30 per cent. to 150 per cent. in excess of the power required for keeping an operation in continuance.‡

The table indicates also that no noticeable reduction or change occurred in the friction of the crane mechanism during a four months' run from June 8, when the crane was first put in operation. The crane was in continual service during that period in handling various loads up to 60 tons. This may be an indication of good workmanship and large wearing surfaces.

Experimental Studies of the Differences of Potential Generated Through Contact of Metals, Liquids and Dry Electrolytes—III.§

BY WALTER NEGBAUR, PH. D.

The result of the first part of the investigation is the experimental confirmation of theory.

It follows from the observations that in equivalent solutions salts with equal anions or kathions follow the law of electro-chemical series. So long as the solutions are equivalent, or nearly so, the direction of the current is determined by that one of the two unequal ions which has the greatest velocity, that ion moving with the positive current. In general, the direction of the current is determined by the relation proposed by Planck $U_1 + V_2 \gtrless U_2 + V_1$.

B. Differences of potential of elements with dry, solid electrolytes.

It is well known that many solid salts conduct electrolytically. Since 1839, when Faraday demonstrated the electrolytic conduction of chloride of lead, the subject has received much attention. Confining ourselves here to the consideration of salts completely free from water, we observe in them the following attributes: First, they have a measurable conductivity only above a certain temperature; second that this conductivity is a function of the temperature, and third, that the melting point is well defined only in few cases.

If pieces of different metals are applied to the surface of such a solid electrolyte, they become charged with electricity just as by the contact with dissolved electrolytes.

If these electric charges produced on the surfaces of the metal be removed by a momentary contact with the earth, they are not immediately renewed, but a certain time elapses before the element again assumes its previous difference of potential. This time depends, among other things, on the resistance of the element.

It is important, therefore, not to use too thick pieces of salt, and also to have very good contact between salt and electrodes. Moreover, the charging of the measuring instrument must take place in a relatively short time; otherwise one cannot be sure that the charges of electricity which are being constantly conducted away to earth become completely removed from the element.

For this reason I have used the Hankel electrometer,‖ which is to be preferred on account of its small capacity.

Fig. 5 shows the arrangement of the apparatus. The condenser $C\,C$ is charged by the battery B. A short fine connecting wire V leads from the aluminium leaf $A\,A$ to the commutators W_1 and W_2. The first W_1 is for the dry element T, the second W_2 for the normal reference element N. By bridging over one of the commutators the aluminium leaf is connected with the earth.

Measurement: In the position 1 of the commutator W_3, the normal element gives the deflection a_1, by commutating W_3, the deflection a_2. Likewise in the position 2 of the commutator W_3, the deflections a_3 and a_4. In the same manner the deflections b_1, b_2, b_3 and b_4 are obtained for the dry element.

The relation of the difference of potential E_1 of the cell in question to that of the Latimer-Clark E_2 is obtained from the following equation:

$$E_1 = \frac{(b_2 - b_1) + (b_4 - b_3)}{(a_2 - a_1) + (a_4 - a_3)} \times E_2$$

* At 500 volts.—EDS. E. W.

† This "actual" work done goes back to that part of the circuit when the voltage was actually 500 or nearly so. If it was that at the dynamo then this actual work includes the loss in the circuits. The figures for the frictional resistances are wrong and too high, unless the voltage was known to be 500 at the terminals of the motor, and even then it includes the electrical losses in the motor and rheostats, which can hardly be called friction.—EDS. E. W.

‡ Electricians will recognize this as being the well-known property of electric motors of being very inefficient at starting. It is not fair to credit the crane mechanism with all that excess of power. Moreover, the author has assumed that the voltage at the motor remained constant even with the great excess of current at starting.—EDS. E. W.

§ Based upon papers published in *Wiedemann's Annalen*, 1891 and 1892. For the first and second sections of this article see THE ELECTRICAL WORLD of Nov. 26 and Dec. 3, 1892.

‖ Blochmann, Wied. Ann. 37, p. 564, 1889.

It was found that in general, by this method, the E. M. Fs. of reversible elements could be measured within 2 per cent.; that of non-reversible elements within 5 per cent.

The E. M. Fs. are, as before, given in volts.

Influence of temperature: The results of the observation of the E. M. F. in its dependence upon the temperature will show the distribution into chemical and electrical energy (H. von Helmholtz); therefore, it would be very desirable to carry on such measurements on these elements, but they are worthless because of the too small charges of electricity at the electrodes. Especially in the air baths they are subject to such considerable fluctuations (the E. M. Fs. often alter suddenly) that the dependence of the E. M. F. on the temperature when it is of such small magnitudes as in the case of solutions cannot be observed. However, a few cells that were beyond a doubt dependent upon the temperature (they polarize very much) were heated in an air bath.

Pt | Pb Cl_2 (cryst.) | Cu. E. M. F. = 0.300.

Temp. cent.	24°	82°	180°	272°	325°	ab. 400°	ab. 550°
E. M. F.	0.289	0.285	0.282	0.304	0.280	0.295	0.301

Temp.	370°	270°	254°	161°	101°	40°	26°
E. M. F.	0.300	0.295	0.301	0.293	0.289	0.275	0.281

Pt | Pb Br_2 (cryst.) | Ag. E. M. F. = 0.402.

Temp. cent.	15°	25°	72°	150°	262°	301°
E. M. F.	0.411	0.410	0.412	0.402	0.399	0.399

Temp	ab. 400°	ab. 550°	250°	138°	100°	20°
E. M. F	0.411	0.416	0.400	0.392	0.400	0.398

A rule for the variation of the E. M. F. cannot be derived from these figures. *In general, however, the E. M. F. alters only very little with the temperature.*

Influence of structure: The electrical behavior of crystals differs very essentially from that of other modifications. This difference is most apparent in the sudden alterations of the conductivity, which with some salts have been noticed during changes in the molecular

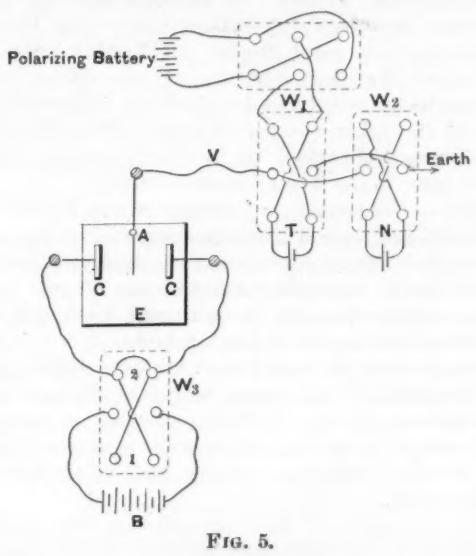


FIG. 5.

arrangement. It is, therefore, possible that the structure of the electrolyte also influences the E. M. F. of an element. There are several ways in which we may proceed to investigate this question.

Crystalline and amorphous modifications: We may measure the compounds of lead, which occur at ordinary temperatures in both the crystalline and amorphous form, directly, with the same metals as electrodes.

The results are given in the following table:

Pt	Pb Br_2 crystal	Ag:	E. M. F. = 0.402
Pt	Pb Br_2 amorph	Ag:	" = 0.400
Pt	Pb J_2 crystal	Ag:	" = 0.392
Pt	Pb J_2 amorph	Ag:	" = 0.409
Pt	Pb Cl_2 crystal	Ag:	" = 0.381
Pt	Pb Cl_2 amorph	Ag:	" = 0.401

The results of this test do not prove conclusively that the structure exerts influence. It should be noted that the amorphous modifications give much more constant results than the crystalline.

Change of color of chloride of lead: This occurs at about 200° C., and is caused by a change of structure. It appears, however, from the figures previously mentioned that the E. M. F. is not appreciably influenced.

Change in molecular structure of HgI_2 at 150° C.:

Pt | HgI_2 | Ag. E. M. F. = 0.411

Temp. in deg. C...	52°	78°	100°	130°	140°	170°	200°
E. M. F.	0.415	0.410	0.398	0.400	0.400	0.391	0.418

Iodide of silver changes at 145°C. from the amorphous to the crystalline condition.

Pt | Hg Br_2 | AgJ | Ag. E. M. F. = 0.129.

Temp.	54°	108°	132°	148°	173°	200°
E. M. F.	0.124	0.123	0.141	0.146	0.130	0.140

The differences of E. M. F. lie within the limits of exactness of the method.

Cold resolidified salt: The combination Ag | AgCl (solid) | Ag Cl (resolidified) | Ag and Pb | Pb Cl_2 (crysto) | Pb Cl_2 (amorph) | Pb give no differences of potential.

From these investigations it appears that the molecular arrangement does not perceptibly influence the difference of potential of the element.

INVESTIGATION OF DIFFERENT ELEMENTS.

The method used permits of measuring the E. M. F. of the dry cells as often as desired, directly after one another, while the very small charges removed by the commutation are immediately replaced. As, however, a measureable polarization only occurs with heavy loading of the element, I have sent the current from an external source through a part of the inconstant elements, and thus determined the value of the E. M. F. with maximum polarization. Most of the elements gave an E. M. F. very different from the original value; with some the difference was small. The figures set forth in the following table indicate the E. M. F. of the elements in volts at the temperature of the room. The values designated as E max. are the results of the measurements with maximum polarization caused by an external source of current. The metal that becomes positively charged always stands first.

(A). Reversible Cells.

a	Ag | AgCl | Pb Cl_2 | Pb:	0.513	0.495	0.523	0.527
	Ag | Ag I | Pb I_2 | Pb:	0.242	0.198	0.203	0.212
	Ag | Ag Br | Pb Br_2 | Pb:	0.421	0.430	0.399	0.423

The first two vertical rows refer to crystalline lead salt the two last to amorphous modifications.

Ag | Ag J (resolidified) | Po I_2 (amorph) | Pb:			0.184	0.180
b	Hg | Hg Cl_2 | Ag Cl | Ag:	0.06—0.09		
	Hg | Hg Br_2 | Ag Br | Ag:	0.07—0.10		
	Hg | Hg I_2 | AI | Ag:	ca. 0.170		
c	Hg | Hg Cl_2 | Ag Cl | Ag:	> 0.02	—	
	Hg | Hg_2 Br_2 | AI Br | Ag:	ca. 0.08	—	
	Hg | Hg_2 I_2 | Ag I | Ag:	0.111	0.112	

If, in the second combination under c, we replace the dry, solid Ag Br by resolidified Ag Br, the E. M. F. remains unchanged.

d	Hg | Hg Cl_2 | Pb Cl_2 | Pb:	0.520	0.500
	Hg | Hg Br_2 | Pb Br_2 | Pb:	0.534	0.519
	Hg | Hg I_2 | Pb I_2 | Pb:	0.309	0.320

The first combination (with Hg Cl_2) conducts very badly. The charging of the aluminium leaf is slow and the values are, therefore, unreliable.

e	Hg | Hg_2 Cl_2 | Pb Cl_2 | Pb:	0.01	0.0	
	Hg | Hg_2 Br_2 | Pb Br_2 | Pb:	0.310	0.99	(unreliable)
	Hg | Hg_2 I_2 | Pb I_2 | Pb:	0.502	0.598	
f	Hg | Hg Br_2 | Pb I_2 | Pb:	0.524	—	
	Ag | Ag I_2 | Pb Cl_2 | Pb:	0.261	0.248	
	Ag | Ag Br | Hg Br_2 | Pb Br_2 | Pb:	0.518	—	
	Ag | Ag I | Hg I_2 | Pb I_2 | Pb:	0.378	—	

(B). Non-reversible Cells.

All combinations with the same electrolyte are brought together in one table under the name of that electrolyte.

(a). Lead Chloride.

Pt | Pb Cl_2 (amorph) | Zn:	0.912	—	—	$E_{max.}$: 1.650
Pt | Pb Cl_2 (crystall) | Pb:	0.576	0.610	0.608	$E_{max.}$: 0.924
Pt | Pb Cl_2 (amorph) | Pb:	0.570	0.570	0.600	—
Pt | Pb Cl_2 (crystall) | Ag:	0.380	0.381	0.396	—
Pt | Pb Cl_2 (amorph) | Ag:	0.401	0.400	0.389	—
Pt | Pb Cl_2 (crystall) | Cu:	0.340	0.312	0.289	0.304
Pt | Pb Cl_2 (amorph) | Cu:	0.270	0.275	—	—
Ag | Pb Cl_2 (amorph) | Pb:	0.169	0.178	0.160	—
Pb | Pb Cl_2 (amorph) | Zn:	0.210	—	—	$E_{max.}$: 0.215

(b). Lead Bromide.

Pt | Pb Br_2 (amorph) | Zn:	0.860	—	—	$E_{max.}$: 1.105
Pt | Pb Br_2 (amorph) | Pb:	0.568	0.598	0.610	$E_{max.}$: 1.23
Pt | Pb Br_2 (crystall) | Ag:	0.427	0.402	—	—
Pt | Pb Br_2 (amorph) | Ag:	0.400	0.411	—	—
Pt | Pb Br_2 (crystall) | Cu:	0.320	0.332	—	—
Pt | Pb Br_2 (amorph) | Cu:	0.300	0.341	—	—
Ag | Pb Br_2 (amorph) | Pb:	0.181	0.169	—	—
Pb | Pb Br_2 (amorph) | Zn:	0.213	—	—	$E_{max.}$: 0.210

(c). Iodide of Lead.

Pt | Pb I_2 (amorph) | Zn:	0.735	0.762	0,753	$E_{max.}$: 1.18
Pt | Pb I_2 (crystall) | Pb:	0.599	0.621	—	—
Pt | Pb I_2 (amorph) | Pb:	0.560	0.589	—	$E_{max.}$: 1.22
Pt | Pb I_2 (crystall) | Ag:	0.452	0.418	0.392	—
Pt | Pb I_2 (amorph) | Ag:	0.409	0.394	0.410	0.401
Pt | Pb I_2 (amorph) | Cu:	0.229	0.213	0.306	—
Cu | Pb I_2 (amorph) | Zn:	0.460	0.432	—	—
Cu | Pb I_2 (amorph) | Pb:	0.215	0.231	—	—
Cu | Pb I_2 (amorph) | Ag:	0.093	0.089	—	—
Ag | Pb I_2 (amorph) | Zn:	0.346	0.333	—	—
Ag | Pb I_2 (amorph) | Pb:	0.174	0.169	—	—
Pb | Pb I_2 (amorph) | Zn:	0.200	0.202	—	$E_{max.}$: 0.210

(d). Chloride of Silver.

Pt | Ag Cl | Zn:	0.197	0.212	—	$E_{max.}$: 1.23
Pt | Ag Cl | Ag:	0.025	0.035	—	$E_{max.}$: 1.23
Ag | Ag Cl | Zn:	0.182	—	—	$E_{max.}$: 0.189
Ag | Ag Cl | Pb:	0.035	0.0230	0,028	—

(e). Silver Bromide.

Pt | Ag Br | Zn:	0.193	—	—	$E_{max.}$: 1.26
Pt | Ag Br | Ag:	0.064	—	—	—
Ag | Ag Br | Zn:	0.189	(unreliable)	—	$E_{max.}$: 0.300
Ag | Ag Br | Pb:	0.019	0.020	0.0220	$E_{max.}$: 0.419

(f). Iodide of Silver.

Pt | Ag I | Zn:	0.196	0.210	$E_{max.}$: 0.810
Pt | Ag I | Ag:	0.071	(unreliable)	$E_{max.}$: 0.676
Ag | Ag I | Zn:	0.149	(unreliable)	$E_{max.}$: 0.67
Ag | Ag I | Pb:	0.0235	—	—

(g). Chloride of Mercury.

Pt | Hg Cl_2 | Zn:	0.09	unreliable.
Pt | Hg Cl_2 | Ag:	0.009	
Hg | Hg Cl_2 | Zn:	0.08	

(h). Bromide of Mercury.

Pt | Hg Br_2 | Zn:	1.091	$E_{max.}$: 1.26
Ag | Hg Br_2 | Pb:	0.238	$E_{max.}$: 0.520

(i). Iodide of Mercury.

Pt | Hg I_2 | Zn:	0.829	$E_{max.}$: 1.452
Ag | Hg I_2 | Pb:	0.07 (!)	$E_{max.}$: 0.368

(k). Compounds of Sulphur.

Pt | Zn S | Zn:	0.812	0.716
Pt | Cu_2 S | Zn:	0.01	0.014
Pt | Tl S | Zn:	0.019	0.018
Pt | Sb_2 S_3 | Zn:	0.402	—

(l.) Miscellaneous Cells.

Pt | Cu Cl_2 | Cu:	0.065
Pt | Cu_2 Cl_2 | Zn:	0.725
Pt | Zn O | Zn:	0.196
Pt | Bor. of Cob. | Zn:	0.385
Pt | Ba Cr O_4 | Zn:	0.852

(To be continued.

Chronological History of Electricity—Part II.—1800-1820.

BY P. F. MOTTELAY.

EDGWOOD (RALPH), member of the family whose name is inseparably connected with one of the most beautiful manufactures of pottery, completes an electric telegraph, upon which he has been steadily at work from 1806. Of its construction or mode of action he appears, however, to have left no particulars.

At pages 178 and 180 of "The Wedgwood's . . . ," by Llewellyn Jewett, London, 1865, appears the following:

This Thomas Wedgwood was, I believe, cousin to Josiah, being son of Aaron Wedgwood, etc., etc. . . He was a man of high scientific attainments, and has the reputation of being the first inventor of the electric telegraph (afterward so ably carried out by his son Ralph) and of many other valuable works. . . In 1806 Ralph Wedgwood established himself at Charing Cross, and soon afterward his whole attention began to be engrossed with his scheme of the electric telegraph, which in the then unsettled state of the kingdom—in the midst of war, it must be remembered—he considered would be of the utmost importance to the government. In 1814, having perfected his scheme, he submitted his proposals to Lord Castlereagh, and most anxiously waited the result. . . was informed that "the war being at an end, the old system was sufficient for the country." The plan, therefore fell to the ground, until Prof. Wheatstone, in happier and more enlightened times, again brought the subject forward with such eminent success. The plan thus brought forward by Ralph Wedgwood, in 1814, and of which, as I have stated, he received the first idea from his father, was described by him in a pamphlet, entitled "An Address to the Public on the Advantages of a Proposed Introduction of the Stylographic Principle of Writing Into General Use; And Also an Improved Species of Telegraphy, Calculated for the Use of the Public, as Well as for the Government."

The pamphlet is dated May 29, 1815. Mr. Fahie gives [1] extracts both from this pamphlet, regarding the electric Fulguri-Polygraph, and from the communication of Mr. W. R. Wedgwood to the *Commercial Magazine* for December, 1846, urging his father's claims to a share in the discovery of the electric telegraph.[2]

A. D. 1814.—Singer (George John), distinguished English scientist and writer, publishes the first edition of his valuable "Elements of Electricity and Electro-Chemistry," of which translations were made, in French by Mr. Thillaye, Paris, 1817, and in German and Italian during the year 1819.

Mr. Singer is the inventor of the capital improvement upon Mr. Bennet's electroscope, which is to be found illustrated and described in nearly all works upon natural philosophy and the main design of which is to diminish, if not totally prevent, the amount of moisture generally precipitated upon the surface of insulators. Mr. Singer remarks that his arrangement so effectually precludes moisture that some of the "electrometers constructed in 1810 and which have never yet (1814) been warmed or wiped, have still apparently the same insulating power as at first." The use of this apparatus is strongly reccomended by Dr. Faraday, whose instructions for the use of electrometers are given at great length at pp. 617-619, vol. viii. of the Eighth "Britannica."

After describing the above named electrometer, Mr. William Sturgeon remarks:[3]

It is frequently exceedingly difficult, without extensive reading, to confer the merit that is due to invention on the right party, and even then we sometimes err for want of proper information. Mr. Singer has hitherto, with most writers, had the exclusive merit of insulating the axial wire of the electroscope from the brass cap, by a glass tube; and it would appear from the description he gives of this improvement, in his excellent treatise on electricity that he was not aware of anything of the kind being previously done. It appears, however, by an article of Mr. Erman in the *Journal de Physique*, vol. lix., p. 98, and *Nicholson's Journal*, vol. x., published in 1805, that a Mr. Weiss had applied the glass tube for the purpose of insulating the axial wire of Bennet's electroscope. The account runs thus; "The electrometer he (Mr. Erman) used was that distinguished in Germany as the electrometer of Weiss." From this it would appear to have been long known. "The length of its leaves of gold is half an inch, and the diameter of the glass cylinder which incloses them is three-quarters of an inch, the height being an inch and a half. Its cover of ivory does not project above the glass, and is perforated in the middle with a hole in which a *smaller glass tube is fixed, and through this last tube passes the metallic rod that serves to suspend the gold leaves.*" Singer's improvement, first published in 1814, would, therefore, consist in adding the brass ferrule, which covers the glass tube first introduced by Weiss.

Mr. Singer is also the inventor of one of the best known amalgams for the cushions of the electric machine. It is described at p. 536, vol. viii., of the Eighth "Britannica," where it is said that a mixture of one part tin and two parts mercury is very effective, as is also the amalgam consisting of mosaic gold and the deuto-sulphuret of tin.[4]

The dry electric columns which Mr. Singer invented are alluded to in *Phil. Mag.*, vols. xli., p. 393 and xlv., p. 359, while the results of his experiments on the electric fusion of metallic wires and the oxidation of metals, as well as those made upon the electricity of sifted powders and to ascertain the effects of electricity upon gases, are to be found recorded at pp. 564, 592, 593 and 597, vol. viii., of the 1855 "Britannica," and at p. 46 (Elec.) of "Library of Useful Knowledge."[5]

A. D. 1814–1815.—Fraunhofer—Frauenhofer (Joseph von), a practical Bavarian physicist and optician, who had been assistant to the celebrated astronomical mechanist, George Reichenbach, publishes his observations on spectra in a pamphlet entitled "Bestimmung des Brechungsund Farbenzer-Streuungs-Vermögens. . . ."

In the latter work will be found detailed his experiments with the electric spark, which he found to give a different spectrum from all other lights. Sir David Brewster says that in order to obtain a continuous line of electrical light he brought to within half an inch of each other two conductors, and united them by a very fine glass thread. One of the two was connected with an electrical machine and the other communicated with the ground. In this manner the light appeared to pass continuously along the fibre of glass, which consequently formed a fine and brilliant line of light. When this luminous line was expanded by refraction, Fraunhofer saw that, in relation to the lines of its spectrum, electric light was very different both from the light of the sun and from that of a lamp. In this spectrum he met with several lines partly very clear, and one of which in the green space seemed very brilliant compared with other parts of the spectrum.[6] He saw in the orange another line not quite so bright, which appeared to be of the same color as that in lamplight spectra; but in measuring its angle of refraction he found that its light was much more strongly refracted, and nearly as much as the yellow rays of lamplight. In the red rays toward the extremity of the spectrum, he saw a line of very little brightness, and yet its light had the same degree of refrangibility as the clear line of lamplight. In the rest of the spectrum he saw the other four lines sufficiently bright. In a subsequent paper read at Munich in 1823 ("Neue Modifikation des Lichtes. . . . ," or "New Modification of Light") and in Schumacher's "Astronomische Abhandlungen" Fraunhofer observes that, by means of the large electrical machine in the cabinet of the Academy of Munich, he obtained a spectrum of electric light in which he recognized a great number of light lines, and that he had determined the relative place of the lightest lines as well as the ratios of their intensities.

The introduction of the electric spark for the purpose of volatizing metals was an important step in the development of spectral analysis, but although used by both Wollaston and Fraunhofer its true value and merit in that particular line were not realized for many years after their time.

Fraunhofer is not only celebrated as one of the founders of spectrum analysis, but he is well known also as the inventor of many important philosophical instruments, being the constructor of the great Dorpat parallactic telescope, called by Struve the giant refractor. It was during the year 1814 that he measured and described the innumerable dark lines of the solar spectrum known as Fraunhofer's lines, which were first noticed by Wollaston and reported upon by the latter to the Royal Society in 1802.[7]

A. D. 1815.—Bohnenberger (Johann Joseph Friedrich von), 1765–1831, professor of mathematics and of astronomy at the Tubingen University, constructs an extremely sensitive electrometer by suspending a single strip of gold leaf upon a wire midway between, though apart from the insulated terminating discs of De Luc's column.

With this apparatus he found that, however slightly the leaf was electrified, it was drawn to one of the poles according to the nature of the electricity affecting it, and he was thus enabled to observe not only the presence of the slightest electrical influence but the kind of electricity which was present.

Noad gives, at page 30 of his "Manual," an illustration of the electrometer as subsequently improved by Becquerel, and states that Mr. Sturgeon describes[8] a somewhat similar arrangement, the delicacy of which he states to be such that the cap (plate) being of zinc and of the size of a sixpence, the pendent leaf is caused to lean toward the negative pole by merely pressing a plate of copper, also the size of a sixpence, upon it, and when the copper is suddenly lifted up the leaf strikes. The different electrical states of the inside and outside of various articles of clothing were readily ascertained by this delicate electroscope.[9]

Mr. Gottlieb Christian Bohnenberger, of Neuenberg (1732–1807), is the author of several works treating particularly of the electrical machine, the electric spark, the electric doubler, etc., published at Stuttgart between 1784 and 1798.

A. D. 1815.—Mr. B. M. Forster sends to the *Philosophical Magazine* (vol. xlvii., pp. 344–345) the description of an electrical instrument called "The Thunderstorm Alarum," which can be made to show the effect produced by the passage of a charged cloud over an *atmospherical electrometer*.

Several years before he described, at page 205 of the same publication, a method of fitting up in a portable form one of De Luc's electrical columns, respecting which latter he subsequently addressed communications, which appeared in vols. xxxv., pp. 317, 399, 468; xxxvi., pp. 74, 317, 472; xxxvii., pp. 197, 265, and one of which he constructed which ran continuously for five months.[10]

A. D. 1815.—Gregory (Olinthus Gilbert), LL. D., professor of mathematics at the Royal Military Academy, Woolwich, in his "Treatise on Mechanics," London, 1815 (vol. ii., pp. 442–449), describes the methods of transmitting distant signals introduced by Polybius, the Marquis of Worcester, Robert Hooke, Amontons and Chappe, and alludes to an improved telégraph described in the "Gentleman's Magazine," as well as to the so-called nocturnal telegraph, of which an account is to be found in the *Repertory of the Arts and Manufactures*.[11]

A. D. 1815.—In the *Philosophical Magazine* (vol. xlvi., pp. 161, 259), will be found an account of the electrical experiments of Mr. De Nelis, of Mechlin, or Malines, in the Netherlands, with an extension of them by MM. George J. Singer and Andrew Crosse.

These allude to many investigations made during fifteen years by Mr. De Nelis who reported upon them to Mr. Tilloch and to Mr. de la Méthérie and which show "very remarkable and permanent evidence of the expansive power of the electric charge." Mr. Singer adds "and it is difficult to contemplate such extraordinary mechanical effects without admitting that the power by which they are produced has at least the leading characteristics of a material substance." At p. 127, vol. xlviii. of the *Phil. Mag.*, is an account of some further electrical experiments of Mr. De Nelis, one of which is intended to improve the simple current with an apparatus not insulated by discs. In this communication, which bears date July 10, 1815, he dilates upon the theory of the two fluids.

A. D. 1816.—Coxe (John Redman), M. D., professor of chemistry in the University of Pennsylvania, is the second to propose a system of transmitting signals, based, like Sömmering's (A. D. 1809), upon the discovery of Nicholson and Carlisle.

In the first series of Dr. Thos. Thomson's *Annals of Philosophy* for 1816 (not 1810), vol. vii., pp. 162, 163, will be found Coxe's letter "On the Use of Galvanism as a Telegraph," wherein he says:

I have contemplated this important agent as a probable means of establishing telegraphic communication with as much rapidity, and perhaps less expense, than any hitherto employed. I do not know how far experiment has determined galvanic action to be comunicated by means of wires; but there is no reason to suppose it confined as to limits, certainly not as to time. Now, by means of apparatus fixed at certain distances, as telegraphic stations, by tubes for the decomposition of water, metallic salts, etc., regularly arranged, such a key might be adopted as would be requisite to communicate words, sentences or figures, from one station to another, and so on to the end of the line . . . . As it takes up little room, and may be fixed in private, it might in many cases of besieged towns, etc., convey useful intelligence with scarcely a chance of detection by the enemy. However fanciful in speculation, I have no doubt that, sooner or later, it will be rendered in useful practice. I have thus, my dear sir, ventured to encroach on your time with some crude ideas that may serve perhaps to elicit some useful experiments in the hands of others. When we consider what wonderful results have arisen from the first trifling experiments of the junction of a small piece of silver and zinc in so short a period, what may not be expected from the further extension of galvanic electricity? I have no doubt of its being the chief agent in the hands of nature in the mighty changes that occur around us. If metals are compound bodies, which I doubt not, will not this active principle combine their constituents in numerous places so as to explain their metallic formation; and if such constituents are in themselves aeriform, may not galvanism reasonably tend to explain the existence of metals in situations in which their specific gravities certainly do not entitle us to look for them?

Coxe does not appear, however, to have at any time made satisfactory experiments, and his systems, as he describes them, were considered impracticable until worked out by Alex. Bain (A. D. 1840).

At pp. 99–110, vol. ii., of Dr. Coxe's *Emporium of Arts and Sciences*, Philadelphia, 1812, will be found his illustrated "Description of Revolving Telegraph," for conveying intelligence by figures, letters, words or sentences, upon which plan, he says, he constructed a small telegraph that worked "readily and appropriately, although by no means fitted with the various pulleys, etc., to facilitate the motion of the ropes."[12]

A. D. 1816.—In part I. of the *Philosophical Transactions* for 1816, and at p. 14, vol. xlviii., of the *Philosophical Magazine*, will be seen an account of the observations and experiments made by Mr. John T. Todd on the torpedo of the Cape of Good Hope during the year 1812.

It is said that the torpedo in this locality is never more than eight, nor less than five inches, in length, and never more than five, nor less than three and a half inches, in breadth. Mr. Todd found the columns of their electrical organs to be larger and less numerous in proportion than those described by Hunter, and that they appeared to be of a cylindrical form, while from a number of experiments he drew, among other conclusions, the fact that a more intimate relation exists between the nervous system and electrical organs of the torpedo, both as to structure and functions, than between the same and any organs of any animal with which we are acquainted. (See Hunter at A. D. 1773).

Reports of another series of experiments, carried on by Mr. Todd, at La Rochelle, during 1816, will be found in the *Phil. Trans.* for the year following, as well as at p. 57, vol. ii., of the "Abstracts of Papers . . . of the *Phil. Trans.*, 1800–1830." The last named investigations were made especially to determine whether the torpedo possessed any voluntary power over the electric organs, either in exciting or interrupting their action, except through the nerves of these organs.

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[1] "History," p. 125-127.

[2] See "Life of Wedgwood," by Miss Meteyard, 2 vols., 1865-1866; J. D. Reid, "The Telegraph in America," p. 70.

[3] "Lectures," London, 1842, pp. 42, 43.

[4] Other descriptions of the application of mosaic gold on the rubber are to be found at: p. 432, vol. ii., of "Young's Course of Lectures;" Woulfe, *Phil. Trans.*, 1771, 114; Bienvena and Witry de Abt, *Lichtend. Mag.*, vols. ii., p. 211, and iv., St. 3, pp. 58-61; Marquis de Bouillon, "Observ. de Physique," xxi.

[5] See also pp. 15, 16 of the last named work; Poggendorff, vol. i., pp. 398, 939; Figuier, "Exp et Hist.," 1857, vol. iv., p. 267; Sturgeon's "Lectures," 1842, p. 11; *Phil. Mag.*, vols. xxxvii., p. 80; xlii, pp. 36, 261; xliii., p. 20; xlvi., pp. 161, 259; likewise Ch. Samuel Weiss, in Poggendorff, vol. ii., pp. 1,357-1,360.

[6] *Edin. Jour. of Sci.*, No. xv., p. 7.

[7] See "Das Leben und Wirken Fraunhofers," Landshut, 1865; Ninth "Encycl. Brit.", vol. ix., p. 737; "Abh. der K. Bayer. Akad. d. Wiss." for 1814 and 1815; Fraunhofer's biography in the Memoirs of the Astronomical Society of London, vol. iii., p. 117; his "Determination, . . ." Munchen, 1819; Whewell, "Hist. of Ind. Sci.," 1859, vol. ii., p. 475; *Sci. Am.*, Nov. 19, 1887, p 321; *Phil. Trans.* for 1814, pp. 204, 205, and for 1820, p. 95; Tyndall, "Heat as a Mode of Motion," 1873, pp. 485, 486; article Optics in Eighth "Encycl. Brit.," vol. xvi., pp. 544, 588 591; Sir David Brewster's article on Electricity in the "Encycl. Brit."; "Mem. of the Roy. Bav. Acad. of Sci.," for 1822; "On the Spectrum of the Electric Arc," in Jas. Dredge's "Elec. Illum.," vol. i., pp. 32, 36; *Edin. Trans.*, vol. viii. for 1822; *Edin. Jour. Sci.*, vol. xiii., pp. 101, 251; *Biblioth. Univ.*, vol. vi., p. 21, as per Becquerel's "Traite, . . . ," vol. i., p. 23; Dr. William A. Miller's first and third lectures before the Royal Institution in 1867.

[8] "Lectures on Galvanism," 1843.

[9] See "La Grande Encylopédie," vol. vii., p. 84; L. W. Gilbert, *Annalen der Physik*, vols. xxiii, (for Behrend's), xlix., li. (for "Beschreibung. . . . empfindlichen elektrometers . . . "); *Annales de Chimie et de Physique*, vol. xvi., p. 91; J. C. Poggendorff, Biogr.-Liter. Handwörtenbuch. . . . ", vol. i., p. 226; *Sci. Am. Supp.*, No. 519, p. 8,290, for Pouillet's remarks upon the effectiveness of dry pile electroscopes; De la Rive, "Treatise on Electricity," vol. i, pp. 54-56.

[10] See also *Phil. Mag.*, vol. iv. for 1828, p. 463; Eighth "Britannica," vol. xxi., p. 619.

[11] See "Biographie Générale," tome xxi., p. 903.

[12] For full explanation of Coxe's systems, see Channing Ev. 46 a; Highton's "Electric Telegraph," p. 39; *Jour. Franklin Inst.*, vol. xxi., for 1851, pp 332, 333; *Comptes Rendus* for 1838, vol. vii., pp. 593, etc.; *Sci. Am. Supp.*, Nos. 404, p. 6,446, and 453, p. 7,234; Alfred Vail, "The American Electro-Magnetic Telegraph," pp. 128, 129; Prime's "Life of Morse," p. 263.

Commercial Electrolysis.—II.*

BY EMILE ANDREOLI.

CHLORATES.

The manufacture of chlorate of potassium is carried out in Switzerland and not in France, as Mr. Swinburne puts it, not under the direction of Mr. Gall de Montlaur (which would be the same as if I spoke of Mr. Ayrton-Perry), but of Messrs. Gall and De Montlaur, the two inventors of the process.

Their anodes are made of thin platinum sheets (one-tenth of a millimetre), which, after having been in constant use for several months, were found not to have lost any weight. Here we are! An anode at last has been found! Why does not Mr. Swinburne mention this very important fact that at the anode a very thin platinum sheet is not corroded by oxygen or chlorine?

As complementary information I will say that in the beginning, Gaul and De Montlaur employed an alloy of platinum and 10 per cent. of iridium, but now they use pure platinum.

The E. M. F. in the preparation of chlorate is 4.34 volts, the current is 50 ampères per square decimetre and the tanks are provided with porous diaphragms.

ELECTROLYSIS OF FUSED SODA.

Mr. Swinburne alludes to the Castner process, and adds, "Whether this process has had any success commercially I do not know."

I can tell Mr. Swinburne that I had last year some price lists quoting the sodium manufactured by Castner at 1s. 8d. or 1s. 10d. per pound; I may also say that this cheapness of sodium has greatly influenced the price of cyanide of potassium.

There was an old process, discovered in 1876 or 1877 by Eislenberger, which consisted in fusing dry ferro cyanide with sodium, but which, for many years, was rendered impracticable by the high price of sodium. Now, thanks to the cheapness of sodium, the manufacture of cyanide is un fait accomph. To return to what Mr. Swinburne calls the problems of Castner, I must say that I find it very surprising that, a few lines after having declared that he knows nothing of the success of the sodium process, he says: "The price of sodium has been reduced recently by the Castner process, but the extraction of the aluminium is still so expensive that electrical methods can compete."

ALUMINIUM.

I am afraid Mr. Swinburne is mistaken when he affirms that aluminium cannot be extracted by ordinary methods. I am told that experiments are conducted at present in London for extracting aluminium from alkaline and earthy alkaline aluminates, and for the simultaneous production of hydroxides of the basic metals contained in the said aluminates; and it appears that the metal will be produced at a trifling price. Further, it has come to my knowledge that demonstrations will be made in this country before the end of this month of the production of aluminium by direct fusion of bauxite at a price of about seven or eight cents per pound. I am a strong partisan of electrolysis, but in some cases its advantages are nil, and I firmly believe that the electric production of aluminium cannot be a commercially paying industry.

There is no problem set in this chapter, but facts and figures only are given.

There are other points to which I might deal, to show how Mr. Swinburne is prejudiced and misleading in his views on the electro-metallurgy of aluminium.

OZONE.

I would never have expected that ozone would be the object of one of the paragraphs of the "Problems of Commercial Electrolysis."

Ozone generated by silent discharges is not and cannot possibly be said to be produced electrolytically. Ozone by electrolysis is quite another thing, and we must no more allow Mr. Swinbourne to assimilate the transformation of oxygen into ozone by electric effluvia to an electrolytic operation than a few years ago the chemists allowed Mr. Fahrig to call ozone an electric gas.

FUSED SALT.

This chapter is rather empty, as we cannot attach much importance to the statement that sodium could be used for "making aluminium, for amalgamation in gold extraction, and for making caustic soda by adding water."

Mr. Swinburne does not state on what authority we may grant that chloride of sodium boils a little above its melting point, and that melted salt is by no means a convenient substance to handle. This, however, is not an insurmountable problem, and if melted salt acts on fireclay crucibles, another material can easily be found.

He timidly advances that "it is said that chlorine will not attack a dry metal, so that iron can be used for the containing vessel." On this point I can assure him that it is so, and chlorine gas is currently sold in cast-iron cylinders.

"We now come to the anodes again!" he exclaims; "retort carbon is eaten away." Of course, it will be destroyed like arc lamp carbons, ex nihilo nihil fit, the only question is: Does it pay to use a destructible carbon anode to get sodium and chlorine?

It is discouraging to read this appreciation of the work of Jablochkoff, Rogers, Beketoff, Grabau, etc.: "So many workers have been unsuccessful with fused salt, that it looks as if there were some insuperable obstacle in the way, and it is questionable whether the ground is worth any future labor." If salt costs only 15s. per ton, as Mr. Swinburne puts it, he ought to be able to calculate the profit to be derived from this electrolysis of fused salt.

As Mr. Swinburne speaks of chloride of sodium boiling a little above its melting point, and of the formation of some sub-chlorides, which is the theory of Grabau, I am surprised that he neglects to tell us that last year Mr. Grabau was producing 100 kilos. of sodium per day, and is very possibly doing so now.

An electrician of his standing ought to speak respectfully of those who, in spite of their indefatigable researches, left the path open to progress, and the history of the induction coil, of Gaulard's secondary generator, and of the present transformers, must render him more indulgent for the pioneers of the electrolytic art, who did not reap what they had sown. But for Gaulard is it certain that we would now have the transformers which are at our disposal?

TIN.

It is to be regretted that Mr. Swinburne does not say more on the recovery of tin from scraps, which, according to him, "can be readily effected." We should have expected to know from him what is the true problem of the separation of tin.

Mr. Swinburne informs us that he does not see how electrolysis can be employed to assist in cleaning plates before tinning, and that he has "examined one of the processes, and it was said to be working very successfully, but found the brushes had been accidentally left off the commutator."

If the brushes were not on the commutator, the only thing to do was to have them put on, so as to be able to form an opinion and to report on the electrolytic process, as compared with the chemical; and people who study the practical pickling of plates by electrolysis will not much appreciate the joke of the brushes. On this, as on many other points, it is impossible to agree with Mr. Swinburne.

"We have improved almost to perfection our plant and machinery," said a tinplate manufacturer to me a little while ago; "there is only one thing which we have not been able yet to modify; it is the cleaning of our plates. We still pickle them exactly as 40 years ago, and in the numerous works of Wales we lose every day a large amount of money in consequence of the waste of acid and of the dissolved iron. We rely on electricity to remedy such a state of things, and I am sure electrolysis will allow us to pickle rapidly and cheaply our black plates. As for me," added the manufacturer, "my works are not large, but still I calculate that every week I lose £17 of acid and good wrought annealed rolled iron, which is uselessly dissolved and goes to the river."

ELECTRIC TANNING.

Here at last we have a problem, as Mr. Swinburne declares "Electrical tanning, though it depends on electrolysis, differs materially from all the processes in not depending on the isolation of radicles at the electrodes." And then he says: "If tannin is an electrolyte, it has a very complex molecule;" and later on, "If the skins are agitated, and electricity is passed, the agitation circulates the liquid into the interstices, and the electric current *sends the tannin through the walls* of the cells"

If so, is not tannin an electrolyte?

WEBSTER PURIFICATION OF SEWAGE.

It is difficult to understand how Mr. Swinburne has come to the conclusion that the Webster process for electrolytic purification of sewage is not on the same basis as the process found by Hermite (after Webster) for disinfecting ships and ports. Mr. Swinburne ought to know better, as the electrolysis of sewage water has been worked since the last few years, and reports and figures on the results obtained have been published.

This sewage process puzzles Mr. Swinburne, who gravely remarks: "There seems uncertainty as to what the action is supposed to be and why the solid particles should be influenced by the current." The Webster process has been worked long enough to deserve more than this passing criticism; but it looks as if Mr. Swinburne had not taken the trouble of inquiring about the working of any electrolytic process in existence, and simply compiled, commented, or summarized the books of Watt and Gore, and the technical papers on the applications of electrolysis. In spite of what Mr. Swinburne affirms, the basis of the Webster process is that water and chlorides, which are always present in sewage, are split up into their constituent parts and produce a disinfecting liquid which is nothing more or less than hypochlorous acid, the most powerful known oxidizing agent and an unstable compound, which, having delivered up its oxygen in oxidizing organic matter, changes into hydrochloric acid, which neutralizes the alkalinity of the sewage. The hypochlorite of iron (his anodes are made of iron) is acted on by free ammonia, sodium, potassium and magnesium hydrates, and the ferrous hydrated oxides precipitate the solid matters in suspension. This particular oxide of iron has the property of combining with organic matter, and takes up more organic matter than if precipitated chemically. In the electrolytic process, the whole of the matter suspended is carried with the oxide of iron, together with a considerable portion of organic matters.

We all learned this long ago from Mr. Webster himself, and Mr. Swinburne forgot it, very likely, when writing that the Webster process is not based on the production of hypochlorite.

ELECTROMETALLURGY OF COPPER.

It is to be remarked that Mr. Swinburne, who devotes a great part of his paper to the description of the well-known Marchese process, does not say a word about the deposition of copper by Mr. J. W. Swan, at the rate of more than 100 ampères per square foot, and which one of the most prominent metallurgists and scientists not long ago called a national discovery.

This part of the "Problems of Commercial Electrolysis," and especially the paragraph on the cost of refining copper, reminds me of the chapter of the "Electrolytic Separation of Metals," by G. Gore, entitled "Cost of Electrolytic Refining." Mr. Swinburne is not complimentary to England when he says: "If a new process is brought out it takes ages before it is taken up abroad and still longer before Englishmen will touch it." He ought not, however, to complain, since his hedgehog transformer has not been long in existence, but is universally known and is applied in many installations in England.

Electricians will also find the sentence he passes on them hard when he says that "chemists are not generally electricians, and electricians are seldom chemists."

(To be continued.)

* From the *Electrical Review* (London). For the first section see THE ELECTRICAL WORLD of Nov. 26, 1892.

The Cost of Electric Supply.—II.*

BY DR. JOHN HOPKINSON.

The actual importance of considerations of this kind can only be realized by examining figures. The figures may as well be estimated figures, because the circumstances vary from one neighborhood to another. No criticism of the details of the figures will affect the general character of the conclusion. Let us then imagine a station capable of supplying 40,000 16-candle lamps at one time, with mains and spare machinery enough to insure that the supply shall not fail, and let us see what the charge for running such a station will be; first, on the hypothesis that it is always to be ready to supply the 40,000 lights at half-an-hour's notice, day or night, but that the lights are hardly ever actually required; secondly, on the hypothesis that the 40,000 lights are steadily and continuously supplied day and night. These are the two extreme cases possible. In the former the load factor is nil; in the latter it is 100 per cent. If the charge is by meter at 8d. per unit, in the former case the revenue will be nil; in the latter it will be £730,000 a year.

We are going to divide the cost of supplying electricity into two parts—a part which is independent of the hours the supply is used, and a part which is directly proportional thereto, and we are going to estimate the amount of each element. It is for the purpose of ascertaining these elements that we consider two quite hypothetical cases—cases which can themselves never actually occur.

We must first have an idea of the capital outlay required. To provide the maximum of 40,000 lamps we need to deliver 2,500 units per hour, and we may estimate the capital outlay as follows:

Land	£25,000
Buildings	15,000
Boilers and pipes	14,000
Engines	24,000
Dynamos	15,000
Switchboard and instruments	2,000
Feeders and mains	50,000
	£145,000

Let us deal with the annual charge for each item of capital separately on the two hypotheses. The charge for land and for buildings including repairs is clearly the same in the two cases, say at four per cent. £1,000 for the land, and at 10 per cent. £1,500 for the buildings. The boilers, engines and dynamos will have a charge for interest, and a charge for writing off, or amortization, as the French call it, that is, for writing off the value of the plant before the time at which it becomes antiquated—exactly the same in the two cases. The boilers, too, will require exactly the same repairs whether they are merely keeping steam or whether they are generating steam continuously; but the machinery will certainly require more for repairs and renewals if it is all running than if a part only is running without load and the rest is standing ready for a load if required. I take four per cent. as the charge for interest; three per cent. for amortization; eight per cent. for repairs and maintenance. Of the repairs of engines and dynamos I assume that two per cent. will be applicable if the plant runs light, the remaining six per cent. if it is fully and continuously loaded. The expenses connected with conductors and switchboard, etc., will be exactly the same whether the current is passing or not; these I take at 15 per cent. The rates I put down at £500 a year. The account, then, for the fixed charges already enumerated would stand as follows:

	Running Light.	Fully Loaded.
Land	£1,000	£1,000
Buildings	1,500	1,500
Rates	500	500
Boilers	2,100	2,100
Switchboard and conductors	7,800	7,800
Engines	2,160	3,600
Dynamos	1,350	2,250
	£16,410	£18,750

We now come to a most important item in the account—the coal. There is no doubt that with uniform and continuous load a unit of electric energy—1¼ horse power for one hour—can be produced for less than three pounds of coal; it is also pretty much admitted that with a load factor of about 12 per cent., but continuous maintenance of pressure, the

* Presidential address before the Junior Engineering Society (London). For the first section of this paper see THE ELECTRICAL WORLD, Dec. 3, 1892.

consumption of coal in good practice is something like seven pounds; that is to say, to keep the boilers warm, turn round the machinery for 24 hours, and deliver full current for 24 hours, will require 72 pounds of coal per kilowatt; whereas to keep the boilers warm, turn round the machinery, and deliver current for three hours, will require 21 pounds of coal. The boilers being kept warm, it will take 51 pounds of coal to generate steam enough to give a unit per hour for 21 hours; 58 pounds to give a unit per hour for 24 hours; subtracting this from 72 pounds, the amount required both to generate steam and keep the boiler warm, we may infer that to keep the boiler warm and merely turn the machinery in readiness to meet a demand will take about 14 pounds of coal per day for every unit per hour the plant is capable of producing. In 1889, for the Society of Arts, tests were made of a Paxman compound engine, from which it appears that a boiler which when fully loaded consumed 40 pounds of coal per hour, required 4.1 pounds per hour to keep steam up to normal pressure when the engine was standing; that is, 10 per cent. of the coal used was used to maintain the steam pressure. Remembering that in addition we keep some of our machinery moving, this may be said to confirm the figures adopted. Thus, if the plant runs light all year round 12,775,000 pounds, or, let us say, 6,000 tons of coal will be consumed. If the plant runs fully loaded, 65,700,000 pounds, or, let us say, 30,000 tons, would be consumed. If we suppose the coal to be the best smokeless it might cost 20s. per ton. Next we have water, oil, and petty stores; say, £600 and £3,000 in the two cases. Wages will be a little less if we run light than if we run fully loaded, and, of course, will largely depend on local circumstances; let us say £5,000 and £7,500 in the two cases. This gives us substantially all the expenses which have to be met and our account will then stand thus:

	Running Light.	Fully Loaded.
Fixed charges	£16,410	£18,750
Coal	6,000	30,000
Stores	600	3,000
Wages	5,000	7,500
	£28,010	£59,250

Thus the cost of merely being ready to supply 2,500 units per hour at any moment throughout the year will be £28,010, and the cost of actually supplying 2,500 units per hour for every minute in the year will be £59,250. The undertaker, therefore, who incurs the liability to supply, ought to receive £11 per annum per unit per hour from those on whose behalf he incurs the liability, and if he receives the £11 he need not charge more than ¼d. per unit for what he actually supplies to cover his expenses. That these figures are fair approximations can be seen as follows: According to this calculation the cost of supplying 2,500 units for one hour per day is £28,010 + 2,500 × 365 × ¼d. = £29,277, and the charge for the service at 8d. a unit would be £30,417; and it is doubtful if such a supply would pay. On the other hand, an indicated horse power on such a scale could certainly be supplied continuously for from £12 to £14 per annum, and according to this calculation an electrical horse power will cost just under £18 per annum. No account is taken of expenses peculiar to companies, such as directors' fees and the cost of forming the company. It will also be noted that it is assumed that accumulators are not used.

(To be continued.)

Oil Versus Air as an Insulating Medium.—III.*

BY JAMES BOWSTEAD WILLIAMS, M. D.

The last test was made with a layer of steam of the same thickness as the layer of air in the test just described.

The quadrants were fully charged and the ground circuit closed. Steam was then generated in a test tube and the mouth of the tube held directly beneath the discs. This enveloped the discs in steam and also formed a layer of steam behind them. As soon as the layer of steam was formed, leakage took place through it, and the leakage increased as moisture was deposited upon the discs (thereby reducing the distance between them) until a bridge of water was formed, when, of course, the quadrants were immediately discharged. From many tests, the writer found that, as nearly as he could determine, the rate of fall when the layer was composed entirely of steam, was about 20 divisions in one second.

He would state, however, that as he was entirely alone during these experiments upon steam, and his attention was necessarily divided between several parts of the apparatus, each of which required continual watching, he cannot vouch for the accuracy of these figures; but he has every reason to believe that they are approximately correct.

Several times during the tests oil was accidently smeared upon the surface of the paraffined hard rubber, and in every case the hard rubber would have to be recleaned and reparaffined before its surface insulation was restored. From a careful consideration of the foregoing tests, the results thereof appear to the writer to prove, when continuous high tension currents alone are concerned:

1. That air, even when it has a humidity of 80 per cent., is infinitely superior to oil for insulating conductors carrying such currents.

2. That pure paraffine is far superior to oil, both for insulating conductors and for preventing the escape of the current across the surface of glass.

3. That air having a humidity of 80 per cent. is superior to paraffine as an insulating medium.

4. That oil will not prevent leakage of the current across the surface of glass.

5. That whenever oil covers the surface of hard rubber, even when the latter is paraffined, it destroys the high surface insulation of the paraffined hard rubber, that is, the low surface insulation of the oil has been substituted for the higher surface insulation of the hard rubber, when used bare and clean, or when covered with paraffine.

The writer would state that the results of the present tests, which were made in New York City, correspond substantially with results obtained by himself and his brother, Mr. R. W. Welty, while they were making the investigation of insulating material and its applications, which is now being described in the serial before referred to.

A few words relative to the use of the oils in practice may not be amiss here. To use oil for insulating conductors, there must be an enclosing vessel of iron, or its equivalent, for the oil and conductors. If long tubes are employed for this purpose, two things are indispensable—plugs in the ends of the tubes and means for keeping the wire or cable concentric with the tube, and the individual wires of a cable separated from each other. For the latter purpose, fibrous material is probably the most convenient means. Jute, when pure and dry, is an excellent fibre, both for the oils when used alone and when thickened with rosins, etc., for by reason of the peculiar nature of the fibre, a larger amount of insulating material can be placed within a given space than if a closely lying vegetable fibre is used; and there will also be fewer points of contact of fibre between the wires and the inside of the tubes. Experiments made by the writer show that there is but little difference in the specific resistance of different kinds of vegetable fibre when the fibre is clean and absolutely dry. The resistance of such fibre is high as long as it remains in this condition. But it is almost impossible to keep it so. It may be a matter of surprise to many to learn that cotton which has been dried, and which therefore possesses good insulating properties, loses these properties in less than ten minutes if exposed to a damp atmosphere.

Whatever means are used for the purpose last above stated, they should have a high specific resistance and allow the use of as much oil as possible.

The plugs must be formed of insulating material which is not injuriously affected by the oils. The best hard rubber, or some special vulcanized rubber or gutta percha compound, appears to be the best for this purpose. Paraffined wood is very apt to be of little use in a short time, for no matter what kind of soft porous material is paraffined by allowing it to absorb the melted wax, the wax rarely hardens in a solid form, but usually contains numerous small spaces and these spaces absorb moisture by capillary attraction. It is for this very reason that a dielectric which is formed of fibre saturated with paraffine soon loses its high insulation when exposed to the air. The microscope will demonstrate the presence of these minute air spaces.

All oil should be carefully heated, sufficient to expel all moisture and air, before it is used. If paraffine oil is used it is better to subject the oil to a comparatively low temperature and exhaust the air by means of a vacuum than to heat the oil to a high temperature. After the moisture has been removed the oil must be kept excluded from the air or it will again absorb moisture.

If oil is used as a covering for insulators made of inferior glass or porcelain, to be of value it must contain no moisture or dirt; and if used in damp and dusty localities means must be provided for the self-renewal of the oil, so that fresh surfaces of oil may constantly be exposed. But if insulators had surfaces formed of glass which contained a large proportion of pure silica, better insulation would be effected if these surfaces were not covered with oil. The writer once found a molded glass vessel, having about the same dimensions and area as the "pony" insulators, which had a surface insulation vastly superior to that of the "pony" insulators. If insulators were made wholly or in part of such material a covering of oil would be worse than useless, for experiments have shown that when glass or other material does prevent surface leakage, covering it with oil at once ruins the high surface insulation.

Experiments made upon the expansion of paraffine and rosin oils show that when paraffine oil is heated to 280 degrees F. a column of it 3½ inches long and three-fourths of an inch in diameter expands one-half of an inch; and that if a column of rosin oil of the same dimensions is heated to the same temperature, it expands three eighths of an inch. These facts should be taken into consideration when using these oils in pipes, for if the pipes are full and the oil gets heated, it will expand and probably either expel the plugs or exude at the ends. If it exudes, dust and moisture will collect upon the film of oil and cause surface leakage. This leakage at the ends of pipes containing telephone or telegraph wires might not be detrimental to the working of the lines, but if the pipes contained wires carrying high tension currents serious trouble might arise.

The efficiency of oil to fill holes in dielectrics depends greatly upon circumstances. If the holes or gaps should be formed in the dielectrics of wires conveying weak currents, the oil, if not too sluggish, would have plenty of time to move into and fill such spaces, but if in the dielectrics of wires conveying strong currents, the oil must move very quickly or a disastrous burnout is the result. And not only this, but the oil, becoming hot, expands, and the pipes, if of lead, are apt to be strained or broken by the increased pressure from within outwards. If the burnout occurs near the ends of the pipes, the plugs may be expelled. If the filling of spaces were the only thing required of the oils, the lighter ones would accomplish this purpose better than the denser ones. But the heavier oils, *e. g.*, heavy and light paraffine oils, are much better for insulating purposes than the lighter.

In conclusion, the writer would state that he feels warranted in believing, unless the contrary can be demonstrated, that dry air, if employed to form a portion of the dielectrics of insulated conductors and if the conditions upon which its highest efficiency depends are fulfilled, is an insulating material superior to oil and even paraffine. In making this statement he stakes it for granted that his method of testing—a method which he does not remember ever to have seen published before his use thereof over five years ago—yields results the accuracy of which can be relied upon. This belief has been established after several years of experimental work upon insulating materials and the manufacture of different kinds of insulated conductors. Certainly air is cheaper than any other insulating material, and it is not destroyed or injured by intense currents. Burnouts do not affect it, and if it can be kept dry, which is the great difficulty attending its use, the conductors which it insulates will have a high insulation resistance and a low electrostatic capacity—two things which are of the greatest importance in electrical engineering.

(Concluded.)

*A paper read at the General Meeting of the American Institute of Electrical Engineers. For the first and second sections of this paper see The Electrical World of Nov. 26 and Dec. 3, 1892.

The Death of Jay Gould and Its Effect Upon the Stock Market.

As has already been announced throughout the country the death of Jay Gould occurred at his home, in this city, on Friday, Dec. 2. The immediate cause of his death was consumption, from which, it is said, he had suffered for some time.

Jay Gould.

Mr. Gould, as an individual, was affectionate, unassuming and well liked. As a public man he inspired terror and distrust. His career in Wall street extended over 30 years, and he did not cease to be a power until the bulletin of his death was posted. There is a popular mistake that he made his colossal fortune in stock gambling. His speculative ventures were usually attended with losses. He amassed wealth by making great hauls from the projects of which he obtained control.

In his telegraph enterprises a consistent purpose is seen. It was from the first his great ambition to control the Western Union Company. "I'd rather be president of the Western Union than President of the United States," he told one of his confidential agents many years ago. But the Western Union was a Vanderbilt property, and he could not buy control against the millions which the Vanderbilts could put up. So he started the Atlantic & Pacific Company, to use it as an entering wedge. In this he failed, the job being too great for his then resources. He was forced to sell out to the Western Union, not on the terms he wanted. But immediately after he started his American Union, and with this he finally accomplished his long-sought purpose. In 1880 the compact was made, the Vanderbilts retired, and as they dropped out Gould had to take their stock.

The history of his career in the street would fill volumes. He was oftentimes hard pressed, and on one occasion, the panic of 1881, he was about ready to make an assignment. He compromised with the bears by turning over to them 50,000 shares of Western Union at $20 per share.

His enormous holdings of stocks have been a menace to other people's plans. Everybody realized that it was useless to bull the market if Mr. Gould was disposed to put out an amount of stock which would check an advance. Mr. Gould's sons will undoubtedly be a factor in speculation at times, but they will not represent the unity of purpose or the consolidated strength possessed and sometimes exercised by their father. His death will have a tendency to minimize the operations of the great bears, Cammack and Sage. There is no doubt that at home and abroad a feeling of distrust prevailed in regard to Mr. Gould's management of railroad properties. Investors will, no doubt, buy stocks and bonds now which they would not have bought with Mr. Gould living.

The extent of the Gould estate has been variously estimated. An authority places it at about the following figures:

Western Union	$22,000,000 par value.	Worth about $19,000,000
Manhattan Elev	10,000,000 par value.	Worth about 13,000,000
Mo. Pacific stock	10,000,000 par value.	Worth about 5,500,000
Mo. P. junior bonds	12,000,000 par value.	Worth about 9,600,000
Other bonds	30,000,000 par value.	Worth about 30,000,000
Total	$81,000,000 par value.	Worth about $77,100,000

Mr. Gould held in addition about $12,000,000 of Wabash stock, a large amount of American Cable, perhaps $2,000,000 of Texas Pacific seconds and some Union Pacific and K. T. stock.

Root Boilers at the World's Columbian Exposition.

The Abendroth & Root Manufacturing Company is one of the six companies which have placed their boilers in the boiler house of the World's Columbian Exposition, and the accompanying illustration is a view of four Root boilers in the process of erection there.

The main part of this boiler is made up of what are termed packages, that is, two parallel boiler tubes are placed about eight inches apart and on each end of these tubes is expanded a cast iron header which is open, inside, like a box, and shaped so as to secure the greatest strength with the amount of metal used. In making up the boiler these headers are piled one upon the other. This arrangement places the tubes so that instead of one standing vertically over the other, they are placed in a staggered position, so that each tube is always over the space beneath, and thus the heated gases from the fire being unable to find any straight passages in their attempt to escape are made to impinge against each tube.

Beginning at the bottom a connecting bend is made to join a header in the lower row to the next header directly above it and so on to the top, where the last bend connects the top header to the overhead drum, and a corresponding series of connections are made with the headers at the opposite ends of the same tubes. Thus it will be seen that the water rises in all of the inclined tubes as it becomes heated, passes directly up through the front headers and connecting bends to the overhead drum, and then the water of circulation passes down in the rear of the boiler through the rear connecting pipes (shown very plainly in the cut), into a drum where it meets the feed water, which is introduced at this point, and there the temperature of the feed water is raised to a point above that which can in any way be injurious to the joints and parts of the boiler.

By referring to the cut again it will be seen that the water passes from the feed drum directly down into the mud drum beneath, and this arrangement makes it impossible for the mud or sediment to become diverted into the other parts of the boiler.

The cut shows, it will be noticed, pipes leading from the top of this mud drum into the bottom of each independent section of the boiler, and thus the coolest water is brought directly to the lower tubes. There is one overhead water drum used for each section, while in other sectional water tube boilers but one or two large drums are used. The makers claim that this arrangement gives a much larger liberating surface and makes the boiler more truly a sectional boiler, giving greater safety and the facility for making steam more rapidly.

The illustration shows, over the rear of these water drums, a multiple, which collects the steam from the steam space of all the drums, and from this multiple it is conveyed through two connecting pipes to a large cross steam drum, extending across the entire width of this boiler. This steam drum is about 8 feet 6 inches long and about 30 inches in diameter, and by comparing the volume of steam held in this drum with the volume of steam escaping from an eight-inch outlet, it will be seen that the ratio is very great; so the steam when it enters this drum, is obliged to wait, as it were, its turn to escape, and while it is thus standing comparatively still, it drops, by gravity, any water it may hold in suspension, which is conducted by piping from the bottom of this drum back into the boiler.

The connecting bends are held up to their place by bolts which have a ball-shaped head, fitting into a socket made to receive them in the headers, which allows a considerable motion in every direction. The ends of the connecting bends are of conical shape, and are received into an extremely flexible packing ring, made of a special metal; this ring (the shape of which might be compared to a half opened umbrella) in its turn is received into an angle shaped seat which is carefully milled out in the header, and when pressure is applied to the end of the bend, through the bolts, the conical end is forced into the ring and this expands the ring into its seat. Another most important feature in this method of connecting the headers is that it makes a flexible vertical section.

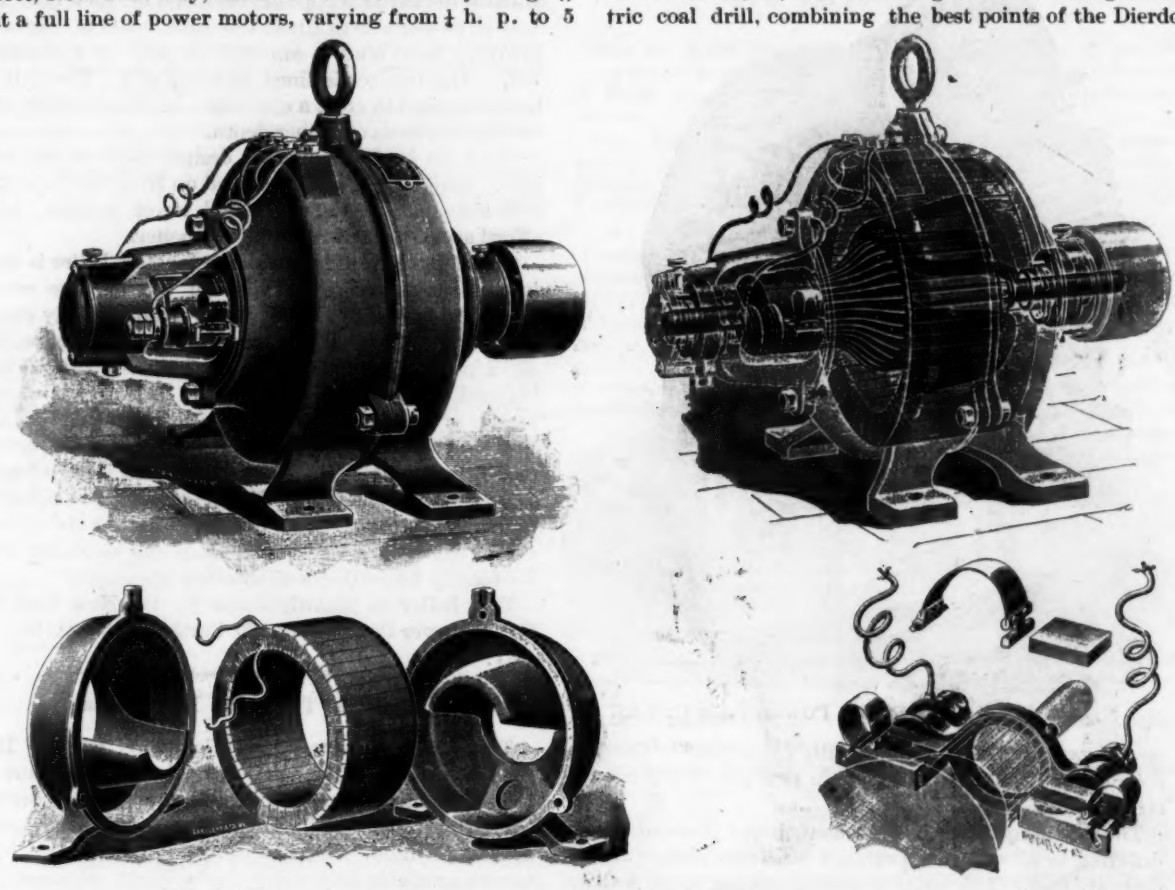
INSTALLATION OF ROOT BOILERS AT THE WORLD'S FAIR.

The Lundell Motor.

The popularity which the Lundell fan motor achieved created a demand for a similar type of larger power, and the Interior Conduit and Insulation Company, 44 Broad street, New York City, has met this demand by bringing out a full line of power motors, varying from ¼ h. p. to 5 h. p. General and detailed views of this motor are given in the accompanying illustrations.

In these larger sizes it has been possible to embody some qualities not obtainable in the smaller fan motor, for instance, by the simple fact of increased dimensions the form becomes cylindrical, and this permits the placing of the field concentric with the armature instead of at an oblique angle. This concentric position of the field coil permits the withdrawal of the armature without disturbing either the field coil or the pole pieces, which is a great advantage in motors of any considerable size. A further modification is obtained by placing the commutator outside of the field magnet shell, but well protected between the two limbs of a broad and strong bracket, which thus affords ready access to the brushes and commutator. Both the commutator and brush holders are of superior design and workmanship, and the latter are quite a novelty in their simplicity. The armature is of excellent design, substantially built and contains maximum cross section with minimum length of wire. The bearings are likewise of a superior design and efficiency, self oiling and provided with a vision gauge. The bushings are made of the best material and are so arranged as to be readily and quickly removed.

In addition to these sizes of continuous current motors this company has in process of manufacture a complete line of smaller powers, ranging from the battery motor of $\frac{1}{12}$ h. p at four volts upward, and including $\frac{1}{10}$, $\frac{1}{8}$ and $\frac{1}{4}$ h. p. Each motor is furnished with a finely finished resistance box, or, if it is desired, the well known Carpenter enamel rheostat.



FIGS. 1 TO 4.—LUNDELL MOTOR.

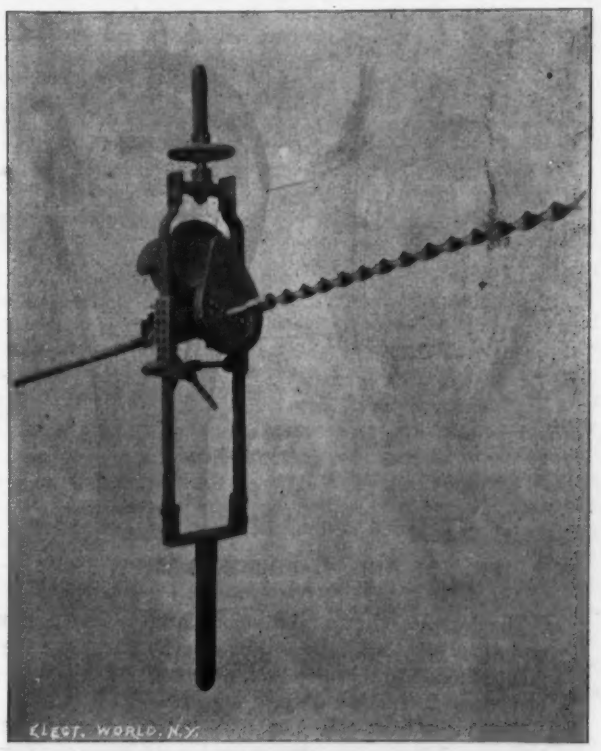
The Jeffrey Electric Coal Drill.

After a series of experimental tests made in practical work in coal mines the Jeffrey Manufacturing Company, of Columbus, O., has succeeding in constructing an electric coal drill, combining the best points of the Dierdorff and Bliss patents, which possesses strength, durability, lightness and simplicity.

The drill consists of a small electric motor hung in an upright frame, having projections at top and bottom, arranged with adjusting screws by means of which it is fastened to the roof and floor of the mine. This is supported by a brace to stiffen and hold the frame rigid while the drill is in operation, although in low veins, with short posts, this brace would not be needed.

The motor is of the iron clad type and will develop 1½ h. p. at a pressure of 220 volts, but can be wound for a lower or higher voltage to suit plants already installed. Everything, field coils, armature, etc., is inclosed, except the commutator brush holders and terminal connectors, the latter being covered by a sheet iron hood, thus preventing dirt and pieces of coal from damaging the armature and field coils. There are but few parts to the motor, and these are easily replaced. The armature and field coils are insulated in the best manner, and all danger of a burned or grounded coil obviated. The motor is not encumbered with a starting resistance, or rheostat, as one is not required.

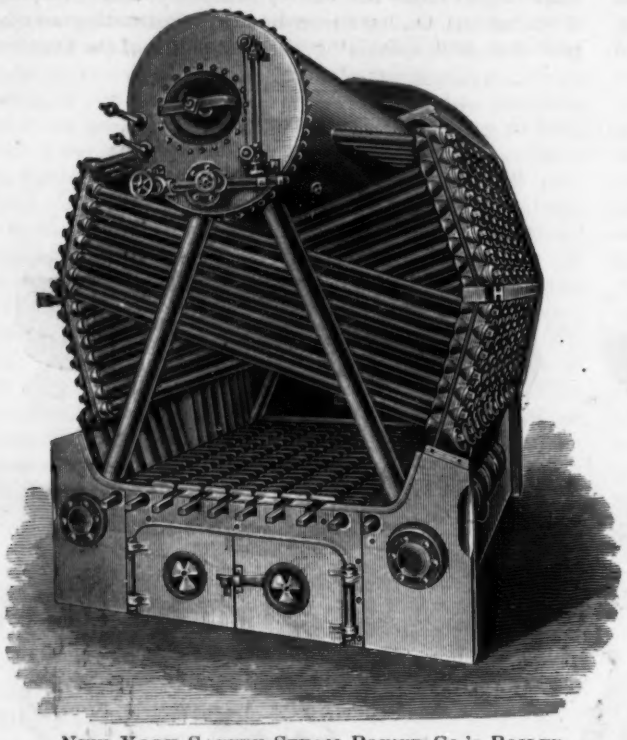
The auger runs at about 300 revolutions per minute and bores a 2-inch hole in from two to four minutes.



THE JEFFREY ELECTRIC DRILL.

The General Electric Company's New Incandescent Lamps.

The demand for a thoroughly high class incandescent lamp, especially adapted to the lighting of street cars, or for use on power circuits, has been steadily growing during the recent months. At the lamp works of the General Electric Company a series of experiments in the direction of satisfying this demand has lately been made, with entire success. The outcome of the experiments is three special types of lamp, which satisfy the exacting requirements of railway and power work. It must be borne in mind that the special requirements of a lamp destined for use in series



New York Safety Steam Power Co.'s Boiler.

on railway circuits differ materially from those of the ordinary lamps which are connected in multiple or low tension circuits.

The first lamp is the straight unanchored filament lamp, differing in no way in appearance from the ordinary incandescent lamp. This lamp is rated according to the amount of current consumed, and only those consuming the same amount of current should be used in any one series. In order to avoid the possibility of errors in order or shipment of this style of lamp, a special record is kept of the lamps shipped to different companies, and thus lamps of the same current carrying capacity as those they may have received on previous orders are always sent to each company.

In the anchored filament lamp the chance of breakage of the filament by sudden contact with the glass of the bulb caused by motion of the car, is entirely obviated. The life of the lamp is, consequently, not exposed to abrupt termination or even abbreviation.

Figs. 1 and 2.—Edison Lamps.

The design of the spiral filament lamp is the most novel and most pleasing. As will be seen by the cut, the filament is made in three spirals, mounted on a heavy glass centre, and requires no extra support.

Great care is exercised in the manufacture of the two last named lamps in order to render the resistance exactly the same throughout each form, so that any "spiral" or "anchored" filament lamp may be used with others of similar form. Neither one, however, must be used in series with the others.

The New York Safety Steam Power Company's Boiler.

This boiler, as may be seen from the accompanying illustration, belongs to the sectional water-tube class, and is designed to secure safety and durability and high evaporating efficiency. It is constructed of materials of superior quality and with the best workmanship. While it is economical in space, at the same time the proportions of the great area and heating surface are liberal. The interior is readily accessible from the outside in every part for examination, cleaning or repairing.

The furnace extends under the entire boiler, and is of proper height to admit of any kind of fuel. The tubes are arranged in transversely inclined series, and every tube is wholly in the furnace directly over the fire and exposed to the full effect of its heat. Every tube is lap-welded and the end connections are expanded. The heating surface and waterways are so arranged that the movement of the water in the boiler is constant and rapid.

The headers are made of steel or iron according to the service required. They are placed close together side by side, forming complete inside walls to the furnace and affording a limited amount of effective heating surface. Outside the furnace opposite each end of each tube a hand hole of proper size to admit the tube or tube expander is provided fitted with a cap held in place by a crossbar and bolt. The furnace is lined with firebrick. The only other brick required to erect a stationary engine consists of two foundation walls of proper depth.

The front is of ornamental design, made partly of cast iron. Hinged doors are provided on front and rear and on both sides opposite the upper and lower headers, so as to afford access to the interior of the boiler.

One of the advantages claimed for this boiler is its absolute safety, as in case of explosion the damage would be limited to one or two tubes which could be easily repaired. Each section of tubes or headers is tested at the works under a pressure of 500 pounds. The circulation is also claimed to be unusually good in this boiler, which is a matter of great importance. It can be seen from the design that the boiler is very compact and consequently its capacity per cubic foot of space occupied is very large. By reason of its sectional character it can be delivered in places wholly inaccessible to most other forms of boilers; as, for example, a boiler of 250 h. p. can be passed through a 4-foot by 4-foot doorway or other opening.

This boiler is manufactured by the New York Safety Steam Power Company, of 30 Cortlandt street, New York City.

Automatic Time and Dating Stamps.

The Accurate Time Stamp Company, 669–685 Hudson street, New York City, has perfected a system of automatic time and dating stamps, time detectors, time recorders and similar apparatus which have given admirable results in actual operation. In factories, shops and many business houses a reliable time stamp is absolutely necessary, while in general business offices it proves very useful in dating letters, orders and documents of every description.

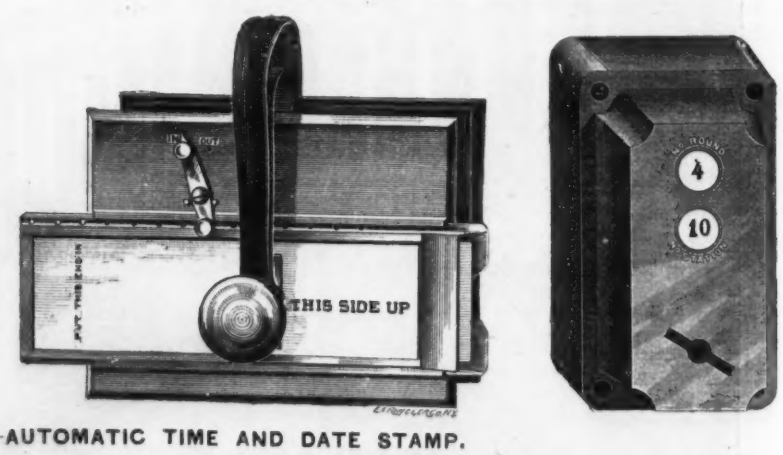
In Fig. 1 is seen the time stamp which this company manufactures. It is operated by the best of marine clock movement and requires no attention but winding once a week. It makes its impression clearly in plain type and straight lines, printing the exact date and time. It is absolutely automatic in setting dates for long and short months, even for February in leap year. It will print the name, business and location and character of the transaction in connection with the correct date and time.

An instrument for taking the time of employés is illustrated in Fig. 2. For this purpose the stamp has an adjustable gauge attached to its top into which the employé slips his time card and stamps it afterward, putting the card back into the card rack. The exact minute that the employé comes in and goes out is thus recorded, and, as the record is absolutely just, it is popular both with employé and employer. It is absolutely impossible to tamper with the stamp so as to change the record in any way.

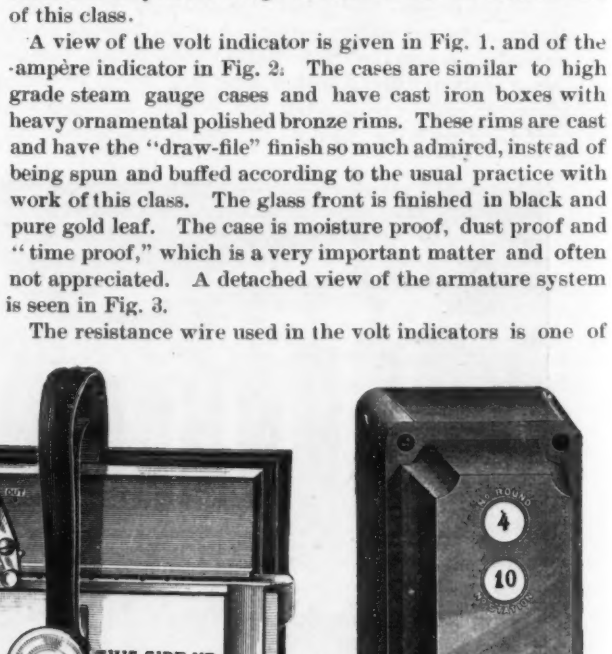
The time stamp can also be used as a perfect watchman's time detector, and for this purpose is made in two forms, one for central use, and the other for use in single stations. The apparatus employed for the former purpose is shown in Fig. 3. The time stamp is placed wherever the employer prefers, and is connected electrically with as many stations as are required. At a given station on his line the watchman inserts a key into a metal station box, thus establishing electrical connection, so that a magnet operates the stamp and makes an impression, giving the number of the station, the date and the exact time. When the watchman inserts his key in the station box two dials in the box are advanced, one showing the number of the station, and the other the number of the line, which serves as an additional check to the automatic record of the stamp.

When the time stamp is connected with a numbering machine it serves as a very useful piece of apparatus to record the movement of messengers, as, for example, in telegraph offices. When a messenger starts out he slips his ticket into the gauge and the number of the service, date, hour and minute are all recorded. Upon his return he again stamps his ticket and places it on record, so that the manager can see at a glance just how much time is consumed.

The stamp is also adapted for railroad use, as it may be placed in each station and caused to record the passage of trains automatically. It may also be used for street railways, either for the dating of tickets or the recording of fares in the cars. In fact the uses to which this style of time stamp may be put are almost without number.



Figs. 1 to 3.—Automatic Time and Date Stamp.



Figs. 1 to 5.—The Wirt Electric Indicator.

The Wirt Electric Indicators.

These instruments are designed to meet the severe conditions of the most exacting practice in commercial electric lighting. The intention of the inventor has been to produce an electrical measuring instrument without the faults of temporary or permanent variation, mechanical defects or imperfect design so often found in instruments of this class.

A view of the volt indicator is given in Fig. 1, and of the ampère indicator in Fig. 2. The cases are similar to high grade steam gauge cases and have cast iron boxes with heavy ornamental polished bronze rims. These rims are cast and have the "draw-file" finish so much admired, instead of being spun and buffed according to the usual practice with work of this class. The glass front is finished in black and pure gold leaf. The case is moisture proof, dust proof and "time proof," which is a very important matter and often not appreciated. A detached view of the armature system is seen in Fig. 3.

The resistance wire used in the volt indicators is one of the new alloys which have appeared in the past few years. The one selected has not the highest resistance nor the least temperature variation of those tested for the purpose. It is superior to 18 per cent. German silver in both qualities and remarkably constant as regards slight change from year to year, which is the most important feature by far in this case.

The interior of the volt indicator is seen in Fig. 4. The action consists of an oblong spool having ends with a cylindrical curve. The armature is a semi-cylinder of thin sheet iron suitably attached to a light steel spindle with conical ends carried in jeweled cups of special shape designed to give the maximum sensitiveness. The attached pointer is made of thin bronze ribbon having the stiffness of tempered steel and formed to a V section. Fig. 5 shows the interior of a 400-ampère indicator, the conductor consisting of a single turn. For large size ampère indicators the "coil" or strap is cast of pure copper.

These instruments are manufactured by the Electrical Supply Company, corner of Randolph street and Michigan avenue, Chicago.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Dec. 3, 1892.

General Features of the Week.—The past was an eventful week even for Wall street. Jay Gould, the great and invincible, has passed away, and now that it is over, and the effects of his death begin to become manifest, a long drawn sigh of relief is heard on every side. It has always been a last resort with the bear clique on times of strong pressure to circulate a report of Mr. Gould's death. So threadbare has grown this expedient that on Tuesday, when it was reported that his health was very bad, little or no faith was placed in the rumor. However, the movement of the various stocks indicated that it might be serious this time. Thursday the decline in Manhattan Elevated, Missouri Pacific & Western Union was pronounced and gave rise to serious apprehensions. The death occurred Friday morning, at 9.15 o'clock. Almost intantly the news reached the street through the agency of Dow, Jones Company. Crowds of excited brokers thronged the exchange and speculated wildly upon the probable effect in the market. The oper ing came at 10 o'clock. The excitement was intense, but each side played a waiting game, and as a result a small panic which might have been precipitated by concentrated action was averted. All of the Gould stocks sold off slightly, but later in the day upon positive news that the most important holdings were, by the terms of the will, placed in trust for the heirs, the ground lost was recovered, and at three o'clock advances were scored, the market closing with a snap that showed unmistakably the relief felt and faith in the future. This was the more remarkable from the fact that the long dreaded gold engagements were made during the day. These it was expected would depress prices. From the firm closing one can assume that Mr. Gould's death more than offset these and other adverse conditions.

NEW YORK ELECTRICAL STOCK MARKET.

In General.—The week's story of this list of specialties is told preceding, and the conclusion which can be drawn is that the out look is one of promise. Certainly a better tone prevails than has been manifest for some time.

Western Union.—Early in the week the condition of Mr. Gould's health led to considerable orders for the sale of this stock. Opinion was divided as t o whether those sales were on account of Mr. Gould, or whether they were by persons who regarded his health a speculative factor. A disposition to sell the stock has been manifest since it crossed 95. It is known that Mr. S. V. White marketed his stock in the vicinity of 97 on the idea that the new stock would be a weight on the market which would be felt for some months, and might easily result in a fall to 80. The feeling also exists that the increased capital of Western Union adds quite a respectable sum to the dividend requirements, and to that extent renders the stock less sound as an investment. Above 85, under normal conditions, Western Union is for the moment regarded by good judges as a sale rather than a purchase. The week opened at 87⅛, and sold down to 85 on Friday The closing on that day was 86, and the highest point reached Saturday was 88⅝. The announcement that the Gould holdings were placed in trust had two bull effects—one, that the stock could not be thrown upon the market in the settlement of the estate, and the other that it will remove from possible circulation just so much stock of a company which is regarded as recapitalized, and will have a tendency to offset the $13,800,000 of stock recently issued. If all of the stocks indulge in an advance next week, Western Union will not be found far from the van; otherwise we do not look for a pronounced advance.

General Electric.—This stock seems to have recovered from its temporary decline. It advanced from 110½ to 113½ in a week, closing strong. Rights to subscribe to the six per cent. debenture bonds sold at from one to five. The range of the old bonds was from 102¾ to 103. The stock was very active, and would indicate that it was being again taken up by professional speculators. If this be true it is in for another advance.

Edison Electric Illuminating.—Limited sales were made at 108½ to 110, the latter being the closing.

North American.—There was a little activity in the stock; prices, however, were low and unchanged at 12⅜ to 12.

Copper Market.—The price of lake copper has advanced ¼ cent to 12½ cents, owing to the close of navigation. Consumer's stocks are only normal, and 12.20 cents for ingots and 12.25 cents for cakes and bars is freely bid, with no takers. Exports of both copper and matte are about normal.

Westinghouse.—But one sale and the first in several weeks, was made on the New York Stock Exchange. It was 100 shares of the E. & W. assenting certificates at 71. The company has fixed its prices for the new lamps, and these will be found on page 374 of this issue of THE ELECTRICAL WORLD.

Electrical Stocks Growing in Favor.—We gave the following interview this week to a representative of one of the financial news agencies in this city: "The first electrical stock to make its appearance in the market was that of Edison Electric Light in 1878. It caused great consternation in the gas stocks owing to the then popular belief that the latter would soon be replaced by the former. There was very little else of importance until 1887 and 1888, when the Thomson-Houston put out its securities. These did not grow in popular favor until 1889 or 1890. The growing importance of the industry and the amount of money called for at last demanded public attention. Earnings in early years of electri cal lighting and power plants were small because of the large sums of money expended in improvements and extensions, much of which were in the nature of experiments.

"The organization of an electric light company has always resulted in such a tremendous demand for light that there has been a constant call for additional equipment. This has also been true of electric street construction, as the establishment of a line invariably increased the traffic. This constant call for expenditure was one of the things that on the start caused distrust among capitalists. The industry was new, problems evolved were unsolved and men supposed to solve them were inexperienced. Again, there is no doubt but what the first success in electric light and power were such as to lead those who were in the business to overestimate actual re sults; this again caused excessive expenditure. The reaction came and with the awakening various enterprises got down to business and found that they had a basis of business operation which was excellent from the point of practical results and possibilities—a good business on which to build a conservative business.

"Public sentiment is monthly growing in favor of the various securities. This is because it is becoming educated. There is still considerable distrust, due in a measure to the supposed mysteries of electricity, which will in time be overcome.

"The wide differences at which some of these securities are held, and the prices bid for them, is attributed to the fact that the owners know their value, where the public does not. There is an excellent field for the companies to educate the public by giving additional information relative to their properties. It is necessary that this information be given out to make these stocks popular.

"In regard to the comparative merits of electric and horse power, the electric light and gas, it may be said that the electric road affords a more solid basis for investment than the horse line. There is more uncertainty in the operation of the latter. The fact that every horse road in the country that possibly can is putting in electricity, while every new road that is being constructed is similarly equipped, is very suggestive.

"I predict a boom for electrical stocks and believe that it is going to be a great one, and for these reasons: The industry has demonstrated its practicability. It has had a phenomenal development and continues to make strides along these lines. Better economic results are reached with it than with other light and power. The holding of the World's Fair calls for a tremendous increase in the manufacture of the various electrical supplies. Almost all exhibitors are going to use electricity because it is the best power. The demonstration of this fact at the Fair will cause its utilization in the factories later. The comparatively new use of electricity in long distance transmission of power in the near future; this may be counted upon as a very large industry.

"Our news reports from every section of the country show that there is a greater number of electric street railroads which are building and seeking franchises than ever before."

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Dec. 3, 1892, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Low-est.	High-est.	Bid.	Ask'd.
American District Tel....	100	3,825,000	58	58	55	57½
American Tel. & Cable..	100	14,000,000	84½	85	85½	85¾
Central & So. Am. Tel....	100	6,000,000	....	....	....	....
Commercial Cables.....	100	7,716,000	....	....	168	175
Gold Stock & Tel.....	100	5,000,000	....	....	100	103
Bonds.....	500	500,000	....	....	100	..
Postal Tel. & Cable.....	...	10,000,000	....	....	62	64
Southern & Atlantic Tel..	25	948,775	....	....	78	84
Western Union Tel.....	100	86,199 852	85	88⅜	87	87¼
Real estate bonds.....	1,000	1,219,000	....	....	....	
Debenture bonds.....	1,000	4,920,000	....	....	....	..
Collateral Trust 5's....	1,000	8,181,000	104¾	105½	....	.
North American.....	100	39,767,200	12	12⅜	12¼	12½
Brush Ill. Co. of N. Y.....	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y.....	100	6,500,000	108½	110	109	109½
" " 1sts.....	...	... .	....	...	...	
" " Deb's.....	...	... .	....	....	....	....
Edison El. Il. of Brooklyn.	100	750,000	....	....	85	90
" " " Chicago..	100	750,000	....	....	130	145
" " " " Boston....	...	.....	....	....	115	125
Edison El. Lt. Europe....	1,000	2,000,000	....	....	2	6
" Bonds.....	...	30,000	....	....	65	80
Edison Ore Milling Co....	...	2,000,000	....	....	15	20
East River El. Light.....	100	1,000,000	....	....		65
General Electric.....	1,000	50,000,000	110⅜	113½	113	113¾
Debenture 5's.....	....	.....	102¾	103	....	....
Automatic Exhibition Co. ...		2,500,000	....	....	3	5
Mt. Morris Electric.....	...	500,000	....	....	....	65
N. E. Phonograph.....	..	2,000,000	....	....	2	4
N. Y. Phonograph.....	...	2,000,000	....	....	2	5
N. American Phonograph ..		2,000,000	....	....	4	6
Westinghouse E. & M. Co. 1st p. 7 per cent., Cum.	50	3,717,253	....	....	....	....
E. & M. Co. Assg.....	50	5,038,116	71	71	....	....

Dewey Electric Heating Company will pay a semi-annual dividend of four per cent. on its preferred stock the 15th of this month—a remarkably good showing for a company only six months old and doing business during the past 60 days only.

BOSTON, Dec. 3, 1892.

The General Market.—With the closing of November ended a remarkable month, so far as the stock market is concerned, and perhaps the most eventful one of the year, for it has been a month of depression in prices throughout the list. October was characterized by general buoyancy. There was not much rise in prices, but the undertone was decidedly strong and the traders were on the long side of the market. With November came the combination of political upheaval, gold exports and losses in railway earnings and December opens in the midst of declining prices, with little prospect of a reaction, and no evidences of interest outside of a narrow circle of professional traders. The average of twenty-five leading stocks closing Nov. 30 was 71¾, this being the lowest point for the whole year. The highest was on March 4, 79½; net decline, 7⅝. On general principles there will be a reaction before very long, as the bottom cannot be much further down, and the opinion is that present prices are better buying than selling. For a week or so conditions must be unsettled, because of gold exports having started in.

In the electric stocks there has been more of activity than usual, and a considerable gain in prices, contrary to the course of the railroad securities, which without exception have been depressed. All the industrials have been strong and active, and are particularly attractive as compared with the rest of the list.

General Electric and Westinghouse have vied with each other in activity during the latter part of the week, and each has gained about three points. The fact of this activity, and that the officials of both companies have been in town, has led to further reports of consolidation, and whether well founded or not, they serve to keep up the interest. From 110 at the beginning of the week General Electric has advanced to 113⅝; and the preferred is off one point to 116 with few sales. The rights on the new bonds have sold at 2½ cents, all of which is paid for commission.

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.—Series Co.....	sh	40,000	9¾	....	9	10
Thomson-Houston Elec.—Series D.....	sh	120,000	8	7⅞	7⅞	8
Thomson Elec. Weld.. ...	100	1,000,000	....	....	....	....
Thomson European Elec. Weld.....	100	1,500,000	7½	....	7½	10
Westinghouse Elec.—New Com.....	..	6,000,000	36⅛	33½	35½	36
Westinghouse Elec.—Pfd.	..	4,000,000	49½	48½	49	50
General Electric.....	..	30,067,200	115⅝	110	112⅝	113
" Pfd... ...		4,136,300	117	116	116	116¼
Fort Wayne Elec.....	25	4,000,000	13½	12¾	12½	13
Fort Wayne Elec.—Ser. A.	sh	80,000	7¾	7¾	7⅝	8
Detroit Elec.....	20	750,000	4¾	4½	....	5
West End St. Ry. Co.—Com	50	7,150,000	73½	72¾	72⅞	73
West End St. Ry. Co.—Pfd	50	6,400,000	87½	87	....	87
American Bell Tel	100	15,000,000	209½	208	...	208
Erie Tel. & Tel. Co.....	..	4,800,000	51⅜	50	49¾	50½
Mexican Tel. Co.....	10	1,280,000	....	....	....	1.10
New Eng. Tel. & Tel. Co.,	..	10,304,600	58	....	58	59
Tropical Tel. Co.....	10	400,000	....	....	....	....

Bell Telephone sells in small lots at the highest figures, 208½ @209½, irrespective of market conditions, and Erie telephone is likewise very strong at its highest prices.

European Welding has sold at its lowest price, 7½, probably a forced sale, since the price seems unreasonable, especially as the company's agent has just returned from Europe with a favorable report of progress. He has given 90-day options for the sale of the patents in the Continental countries, and is sanguine of completing the negotiations for them within that time.

West End Railway stocks continue active and strong, never lacking support. The prices have not materially changed from about 73 for common and 87 for preferred. A dividend of five per cent. on the common stock and one of 1 per cent. on the preferred stock are payable Jan. 2, 1893. These are the regular semi-annual dividends.

Westinghouse preferred stock pays its regular semi-annual dividend Jan. 3, of 3½ per cent. to stockholders of record Dec. 20.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stocks furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago.....	214	....	Chicago Arc Light & Power Co.....	102¼	103
Central Union	....	58	Chicago Edison Co ..	170	....

NEW INCORPORATIONS.

The De Kalb Electric Company, of De Kalb, Ill., capital stock $60,000, has been incorporated to furnish electricity. Samuel E. Bradt, John W. Gliddne and Madison D. Shipman are the promoters.

The Edwardsville Electric Light and Power Company, Edwardsville, Ill., capital stock $20,000, has been formed to operate an electric light and power plant. Wm. Wurdack, Chas. P. Sampel and Wm. H. Horine, Sr., are the promoters.

The Harrison International Telephone Company, Chicago, Ill., capital stock $80,000,000, has been formed. The organizers are Charles M. Ferrol, Kansas City, Mo.; Edward M. Harrison, Fort Smith, Ark., and Albert L. Stone, Kansas City.

The Walnut Hills District Telegraph Company, Cincinnati, O., capital stock $25,000, has been formed to furnish messengers, etc., etc.; system of electrical signals, etc. I. N. Miller, C. E. Page, E. V. Cherry, Alfred Hill and Lewis G. Hopkins are the incorporators.

The Monrie Water-Works and Light Company, New Orleans, La., capital stock $135,000, has been formed to operate water-works and electric light plants, etc. Irwin Jamison, L. E. Cenas, L P. Walmsley, Wm. M. Bailey and Branch R. Miller are the incorporators.

The Electric Selector and Signal Company, New York City, capital stock $150,000, has been formed to construct all kinds of electrical or mechanical apparatus pertaining to electricity. John C. Bates, C. W. O'Connor, W. J. O'Connor, all of New York City, are the promoters.

The Longview Electric Light and Power Company, of Longview, Tex., capital stock $10,000, J. M. Mobberly, president; W. C. Page, secretary and treasurer, will erect a plant of not less than 500 incandescent light capacity to supply the towns of Longview and Longview Junction.

The Boone Electric Street Railway and Light Company, of Boone, Ia., capital stock $.00,000, has been formed to build and operate an electric street railway, and to furnish electric light and power. Eli H. Chandler, Charles French, S. T. Stanfield, Loran W. Reynolds and C. E. Rice, Boone, Ia., are interested.

The Elberton Improvement Company, Elberton, Wash. capital stock $6,000, has been formed to operate and control water works, street railways and electric light plants, etc. W. N. Ruby J. C. Benton, of Colfax, and A. Long, J. E. Price and Anderson Wait, of Elberton, Wash., are the promoters.

The Marion Electric Railway, Light and Power Company, Marion, O., capital stock $100,000, has been formed to construct and operate a street railway and to furnish light, power, etc. Dan. Babst, Jr., Wm. E. Scofield, Caleb H. Norris, Edward Huber and Daniel A. Frank are the incorporators.

Kirkwood, Webster & St. Louis Railway Company, Kirkwood, Mo., capital stock $2,500, has been organized to construct a railroad from St. Louis to Kirkwood, to be operated by electricity, or other means. The incorporators are Aug. Herman, F. W. Roeder and G. W. Taussig, all of St. Louis, Mo.

The Flatlands Electric Light and Power Company, Flatlands, N. Y., capital stock $50,000, has been formed to produce electricity for light, heat and power. Mirabeau L. Towns, 150 Quincy street; Francis Gross, 315 Gates avenue, and Henry A. Gehrhardt, Jr., 248 Hart street, Brooklyn, N. Y., are the promoters.

The Electric Railway and Improvement Company of Staten Island, Jersey City, N. J., capital stock $200,000, has been incorporated to purchase and operate electric light, heat and power works, etc. C. Detrick, T. T. Greens, both of New Brighton; J. Brown, P. Thompson, L. Semple, all of New York, and P. Ward and J. F. Ward, of Jersey City, are the promoters.

The Cinnaminson Electric Light, Power and Heating Company, Riverton, N. J., capital stock $50,000, has been formed to erect electric light plants and to supply electricity for lighting, heating, etc. W. V. Massey, Philadelphia, Pa.; Mitchell B. Perkins, Beverly, N. J.; I. E. Maguire, J. Hartley, Palmyra, N. J., and A. J. Briggs, Riverton, N. J., are the promoters.

The Pacific Bear Electric and Power Company, Los Angeles, Cal., capital stock $1,000,000, has been formed to acquire exclusive rights to patents owned by the Bear Electric Company and Columbian Light, Heat and Power Company, of Chicago, and to manufacture and sell apparatus and machinery and deal in and distribute light, heat and power, construct and operate railways, etc. Geo. J. Ainsworth, Thos. M. Gibson, Albert M. Stephens and Jas. N. Sutton, all of Los Angeles, and F. W. Ludovici, of San Francisco, are the promoters.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, Dec. 5, 1892.

Mr. J. E. Ham has been appointed general agent of Day's Kerite wire, at the New York offices, 203 Broadway. Mr. Ham's business experience well fits him for this work and he is entitled to the congratulations of his many friends.

The Stimson Institute for Artists-Artisans, 140 West Twenty-third street, New York City, was founded four years ago to provide the artisans of America with that which is within the reach of the corresponding classes abroad, that is, with a practical art culture adapted to the useful arts, and the encouragement of a correct taste and a thorough technique among the designers and artisans of this country. Within these four years over 400 students have been educated with most gratifying results. At present the teaching force consists of 12 specialists in charge of Mr. Stimson, and the range of instruction embraces most of the ornamental electric arts. What is immediately needed is the practical support of men who appreciate the importance of this movement, and it is hoped that such support will be forthcoming.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 31, CITY TRUST BUILDING, 917 Chestnut St.,
PHILADELPHIA, Pa., Dec. 3, 1892.

The Southern Electric Company, of Baltimore, Md., is a very busy concern, and reports more orders than it can handle.

The Electric Bureau of Philadelphia, Pa., has asked for an appropriation of $290,210 as compared with $261,793 for the past year.

Messrs. Wm. Weston & Co. are still working their men overtime, and have enough of orders now on hand to keep the company busy for six weeks.

Mr. N. Marcus, dealer in telephone auxiliary mouth pieces, reports that the sale of his auxiliary mouth piece is exceeding his most sanguine expectation.

W. C. McIntyre & Co., Philadelphia, agents for the Eddy motor, report the motor business exceedingly lively, with prospects of its continuance for some time to come.

Mr. C. E. Trump, of the Novelty Electric Company, has returned from a business trip, having been absent for a month. Mr. Trump reports business exceedingly brisk.

Mr. Wm. N. Famous is the Philadelphia agent for the Electrical Manufacturing Company, of Oconto, Wis., office 103 Vine street. Mr. Famous reports a great demand for the "Brilliant" incandescent lamps, and is away behind in orders.

West Philadelphia property owners recently sent a delegation to Mayor Stuart urging him to sign the ordinances granting overhead trolley privileges to the Elmwood & Fairmount Park Passenger Railway Company and the Fairmount & Haddington Passenger Railway Company.

Mr. Wm. McDevitt, chief of electrical department of the Philadelphia Board of Underwriters, expects to sail for Europe next month, and will visit London, Liverpool, Paris, Berlin and Vienna, for the purpose of inspecting the different systems of wiring and electric lighting.

Messrs. C. H. & H. Stanton, electrical supply dealers of Philadelphia, have received orders for several electrical ornaments such as are used in decorating stores and private houses. Among some of the designs of these ornaments is a star of flowers about 2½ feet in diameter, with a small incandescent three candle power lamp placed in each flower. Another beautiful design which this company is now getting up is a basket of fruit about 2½ feet long by 2 feet diameter, which is also decorated with incandescent lamps in the same manner as the star.

The Acme Gas Fixture Company, located at 1,236 Filbert street, though in the field but a short time, has made its influence very strongly felt by its competitors. This company is showing full lines of various productions, comprising some of the latest combination gas and electric fixtures in the market. The company has in its employ some of the best designers in the business, and it keeps up a constant succession of new and beutiful designs, including wrought iron work in many handsome patterns. The company has filled many very important contracts, and others are under way. It is rapidly building up a splendid business among the leading houses of this city and surrounding country. This company is supplying the College of Pharmacy in this city with combination gas fixtures of an elaborate and artistic design.

N. D. W.

PITTSBURGH NOTES.

PITTSBURGH, Dec. 3, 1892.

The last horse car will have vanished from the streets of Pittsburgh by next spring. The Allegheny Traction Company, the only street railway corporation of this city which operates its lines by horses, at a recent meeting decided to adopt electricity as a motive power. The change is to made immediately.

The City Attorney of Pittsburgh yesterday filed suits against four local electric street railway companies to recover from these corporations' the car tax alleged to be due the city. There has for some time been a movement going on here to make all street car companies pay a tax of $50 per car, and this action of the city attorney is the first definite move to enforce that law.

The Pennsylvania Railroad Company's electric light plant at the Union station was put into operation yesterday. Last evening the big building, the yards adjoining and the Lawrenceville yards were all lighted through the agency of the new plant. Light will be furnished for every station as far out as and including East Liberty. No expense has been spared by the Pennsylvania Company in the erection of this plant, and the result has been the construction of a model one, under the direction of W. H. Markland, of Altoona, chief of construction of the Pennsylvania Railroad Company's electrical department between Pittsburgh and Philadelphia. The plant cost about $40,000. The machinery is contained in a substantial brick building 30 × 80 feet. Two Greene engines of 125 h. p., each resting solidly on firm bases under the concrete floor drive two 50-light Thompson-Houston arc, and two 600 light Westinghouse alternating dynamos. There is room for another engine, so that the capacity of the plant can be greatly increased. The engines have been set so level and firmly that one of the electricians yesterday balanced a penny on edge on the curved surface of the cylinder head while the engine was running at full speed. The machine is perfect. A battery of two Heine safety boilers of 200 h. p. each furnished the power. They can be increased to 350 h. p. each if necessary. The coal used is, by a convenient switch, run into the boiler room in cars and there dumped into the coal bins. The exhaust steam is utilized under the Webster vacuum system, and will heat the station. An adjunct of the plant is a 120-foot smokestack, the foundation of which is brick. Very little smoke was issuing from it yesterday, and the aim is evidently to obey the city ordinance against the smoke nuisance. D. B. Kinch, late of Philadelphia, will have charge of the plant. The officials of the road are well pleased with it.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Dec. 3, 1892.

Electric Car Heaters will be extensively used this winter.

The Boston Gear Works, of Boston, have an interesting exhibit of their gears of all kinds and turn table for show window at the Mechanics' Fair.

Mr. C. S. Sargent, formerly second vice-president of the West End Railway Company, and acting general manager since Mr. Monk's resignation, has been appointed general manager.

The Gethins Electrical Manufacturing Company has received an order to equip the new "Metropolitan Duplex Fire and Police Telegraph" system at Salem, Mass., with its improved gravity battery.

Mr. H. B. Thorne, of the Consolidated Electric Company of St. John, N. B., was recently given a large reception and presented with a well filled purse by his fellow employés, after which Mr. Thorne left for his new home in Chicago.

H. N. Bates & Co., of Boston, have a large and attractive exhibit of friction clutch pulleys and cut-off couplings, machinery, patent turned shafting hangers, self-contained engines, etc., in Machinery Hall, Mechanics Building, near the western end.

Mr. William H. Hine, formerly with the United States Electric Lighting Company, and later with the general district agent for the Westinghouse company, has accepted the position as general sales agent of the J. I. Case Engine Company, with headquarters at New Britain, Conn.

Mr. Wm. C. Nairn, who has been connected with the Laminar Fibre Goods Company, of Boston, since its inception, is now representing that company on the road. The thorough knowledge which Mr. Nairns has of the company's product, coupled with his many other excellent qualifications, will soon make "Laminar Fibre" known to all of the trade.

Superintendent J. W. Wentworth, of the East Middlesex Street Railway Company, has resigned to accept a position on the Amesbury & Haverhill electric road. Mr. Wentworth has been popular among the employés, and his removal from Malden is deeply regretted by his friends. Mr. John Sewall, of the North Woburn road, is his probable successor.

The Rutland (Vt.) Electric Light Company, M. J. Francisco, vice-president and general manager, recently gave a very brilliant electrical entertainment for the Rutland Free Library. Among other interesting things was an electrical star containing 223 lamps, and making over 40 changes, a photo-engraving lamp, a search light, a wheel, an electric fountain, all of which was supplemented by a very beautiful "Electra" dance.

The Worcester, Leicester & Spencer Street Railway Company has filed a petition with the secretary of State, to be presented to the General Court, for authority to purchase and consolidate any or all street railway companies having locations in said cities or towns, and to issue bonds to increase their capital stock. They also ask for authority to change the name of the companies to the Worcester and Suburban Street Railway companies.

The Westinghouse exhibit in Machinery Hall, at the Mechanic's Fair, of compound, standard and junior engines, and other machinery is worthy of notice. The large compound engine of 250 h. p., which runs all the shafting in the fair, is located next the boiler room, and attracts great attention from its new form of construction, massive proportions and noiseless movement. The main exhibit is near the central stairway leading to Exhibition Hall, and consists of three special features, one of which comprises a 10 horse engine directly connected with a 100 light Mather dynamo.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Dec. 3, 1892.

F. Minot, general manager of the National India Rubber Company, Bristol, R. I., spent several days last week in Chicago, returning East on Friday.

Mr. James F. Cummings, of Cummings & McCoy, Detroit, has been in Chicago during the past week in connection with his underground street railway system.

The Commercial Electric Company, 113 South Tennessee street, Indianapolis, Ind., has issued a price list of its constant potential dynamos and motor generators.

Mr. P. L. Rose, of the Rose Electric Light Supply Company, of St. Louis, was a World's Fair visitor this week. Mr. Rose has enjoyed a profitable season of "trading," and rejoices accordingly.

Mr. H. C. Thomson, representing the Electric Gas Lighting Company, 195 Devonshire street, Boston, Mass., is touring through the West, and was the guest of manager C. E. Lee while in Chicago this week.

Mr. Carl Kammeyer, formerly the electrician of the National Electric Manufacturing Company, of Eau Claire, Wis., will probably be associated with Mr. Charles D. Jenney at the factory of the Jenney Electric Motor Company, in Indianapolis, Ind.

T. A. Pamperin, president and general manager of the Electrical Manufacturing Company, Oconto, Wis., made the Chicago office of THE ELECTRICAL WORLD a very pleasant visit on Wednesday last. The "Brilliant" incandescent lamp, manufactured by this company, is having a very large sale, and some flattering testimonials have been received as to its merits.

Mr. A. D. Adams, manager of the Commercial Electric Company, Indianapolis, Ind., is a World's Fair visitor this week, and reports a nice line of orders already received for his special form of motors, dynamos and motor generators, the field magnets of which are built throughout of forged iron, thus forming rather a unique type of machine that will probably prove very efficient under a changeable load.

The American Battery Company, of Chicago, reports an increased demand for its new Planté storage cell. Among recent shipments is one of ten cells to Sidney, Australia. This company has its new factory completed and is prepared to turn out the battery in large quantities. Different forms for phonograph, street car and general work have been perfected, and the outlook for a very large sale is most promising.

The Electric Appliance Company has just rounded out its first business year, and reports that the results have been highly satisfactory in every way. The company will begin the new year by calling the attention of the trade to several recently acquired specialties of considerable interest. Its facilities have been increased in every direction, and the prospects for a heavy business for the coming year are very flattering.

W. B. Roberts, general manager of the Rockford Electrical Manufacturing Company, was in Chicago the greater part of last week on business connected with his local agency. Among recent installations made in Chicago by this company are the following: W. W. Campbell Company, 400 lights; Roth & Englehart, 200 lights; M. Steeger & Company, 150 lights, and Chas. M. Hansen & Co., 50 lights. Several fine plants have also been installed in Milwaukee during the past two months, and business is reported as being exceedingly good.

Mr. F. W. Cushing has resigned the Western agency for Kerite wire to become identified with the Gray Telautograph Company which is soon to place its instruments on the market. Mr. Cushing's place will be taken by the firm of Cushing & Morse, consisting of H. A. Cushing and S. F. B. Morse, two gentlemen who have been identified with this agency for some time. They are both well known to the trade, and will undoubtedly meet with success in their new undertaking. The change took place on Dec. 1.

The Chicago Electric Association will hold its next meeting on Dec. 13, in the Athenæum Building, 26 Van Buren street, when Mr. Albert Schiebel will read a paper on "Three Way Incandescent Switches and Their Uses." The young men engaged in practical electrical work should not fail to send in applications for membership to this association at an early moment in order to get the full advantages that will accrue from associating with the active and progressive young workers who form the present membership.

Mr. E. L. Babcock, president of the Fails Rivet and Machine Company, has been in Chicago this week arranging for his extensive exhibit at the World's Fair. Already several car loads of shafting and clutch couplings are on the grounds, and will be placed in position a a moving exhibit as rapidly as possible. Mr. Babcock mentioned the great interest that has been awakened among central station men regarding the coming meeting of the National Electric Light Association in St. Louis in February next, and he expects there will be a far larger attendance than has been enjoyed at any previous meeting.

Another new electrical journal is to be started in Chicago Jan. 1. It is to be called *World's Fair Electrical Engineering* and according to the postal card announcement will be published by "Electrical Engineering Publishing Co., Fred De Land, Editor.' One of the principal objects which the new monthly will have in view will be to so educate electricians beforehand that when they visit the exposition "whether the trip is made in January or July," they can "intelligently inspect the specific portion of each section most interesting" to them. Its projectors have our best wishes for the success of their new venture.

The Enterprise Electric Company is moving from its old quarters at 315 Dearborn street to 307 Dearborn street. The company's new rooms will extend through the Manhattan Building from Dearborn street to Plymouth place, including two rooms on the main floor and a fine basement store room. Mr. W. F. Richardson, of this company, has just returned from the East, and as a result of his trip, the N. I. R. Company will soon ship two car loads, or about one and one half million feet, of its celebrated wire to be distributed from Chicago. Several very fine contracts have recently been made by the Enterprise company for this wire, and the demand is reported on the increase.

Mr. F. G. Beach, general superintendent of the Central Union Telephone Company, has just issued a general circular announcing the appointment of B. F. Lloyd as superintendent of that company for the State of Ohio, with headquarters at Columbus. Mr. Lloyd has been for some years connected with the United Press, as superintendent of the news service in Chicago. He was formerly superintendent of the American Union Telegraph Company in Philadelphia, and later manager of the Western Union Company in Pittsburgh. Mr. Lloyd enjoys a wide acquaintance, and will, undoubtedly, fill his new position with credit to himself and the company. His appointment dates from Dec. 1. D. H. G.

TACOMA, Wash., Nov. 29, 1892.

The Northwest Supply Company, through Charles S. Bowie, manager, has received the contract for wiring the Olympic Theatre building for 400 incandescent lights, Westinghouse system.

The A. F. Espersen Company, of Tacoma, has been awarded the contract to supply the elevator equipment for the new Board of Trade building in Victoria, B. C. A Kieckhofer elevator will be used, driven by an Edison motor.

The Tacoma Railway and Motor Company has increased its station equipment by the installation of two standard Edison railway generators, capacity 175 kilowatts each. An additional Eclipse Corliss tandem compound engine of over 900 kilos is ready to be started up. Ten new single truck cars have recently been completed in the company's shop. G. R. De V.

CANADIAN NOTES.

OTTAWA, Dec, 3, 1892.

The Bell Telephone Company has decided to construct a new direct line between Port Hope and Kingston.

A quarterly dividend of two per cent. on the paid up capital stock of the Royal Electric Company, of Montreal, has been declared.

St. Catherines, Ont.—The present street railway line to Thorold will be rebuilt in the spring, and there is a possibility of its being continued down to Port Dalhousie.

Montreal.—Electric cars will be run all winter on St. Catherine street and also on Craig street, from St. Charles Borromeo, up Bleury, to the west end of St. Catherine street.

The Hamilton Street Railway Company intends to apply to the Ontario Legislature to have its act of incorporation so amended as to enable the company to increase its borrowing powers.

David Wees, the proprietor of the Weesbeach summer hotel, has a street railway project on foot, which, if successfully carried out, will bring Weesbeach and its pleasant environs into almost immediate connection with Sarnia, Ont.

Windsor, Ont., is to have electric power works. H. P. Dwight and Frederick Nicholls, president and secretary of the Canadian Electrical Company, have been in the city looking up a site for a power house for the People's Electric Light Company.

T. Ahearn, of Ahearn & Soper, has been in consultation with the firm of Frost & Wood as to the possibilities of constructing an electric railway from the shops of the company to the line of the Canadian Pacific Railway in order to save the long haul by wagon.

The National Electric Light and Tramway Company, of Victoria, B. C., has decided to increase its capital stock to $1,000,000, and has authorized the directors to raise by way of loan or debentures $500,000. Important improvements in the system are looked for.

W. O. Sealey, J. I. Flatt and Solicitor Evans, of the Hamilton, Watertown & Guelph Electric Railway, have appeared before the Guelph Board of Trade and received an indorsement of their scheme. The application of the company for a charter will be sent to Toronto at once.

Westville, N. S.—The Electric Light Company is putting in a large number of incandescent lights, having taken the arc lights out altogether. A large number of consumers are putting in the meter system, including the Acadia Coal Company, which is lighting the bank head and surface workings.

The Montreal City Council has had a petition presented to it, signed by a thousand people, asking that the electric cars be not allowed to run in winter. The petitioners fear that the snow thrown off by the sweepers will block up the streets, and that the bare rails of the track will interfere with driving,

Toronto.—A new street car line is proposed from the foot of York street to Queen, then up University street, through Queen's park, passing the new Parliament Buildings. It will be a direct route from the lake front and Union Depot to the Parliament Buildings and many educational institutions in the vicinity.

Brantford, Ont.—A meeting of the manufacturers of the city has been held to consider the advisability of erecting a central power station to furnish power and light to the manufacturers. All present were in favor of the scheme, and a committee was appointed to find out the cost of the plant and electric power.

The People's Electric Light Company, of Windsor, Ont.,

has been organized with a capital stock of $50,000. It will operate the light now owned by the Edison company. The majority of the stock is held by John Davis, W. J. Pulling, Dr. Coventry, W. J. McKee, James Anderson, A. McKee, Frederick Nichols and H. P. Dwight.

Guelph, Ont.—There is considerable talk on the streets over the proposed electric railway between Hamilton and Guelph. Opinions differ as to the amount of benefit which Guelph would derive from having the road built, and nearly all say that it should run farther north and take in Elora, Fergus, Erin, Mt. Forest and other places in the neighborhood.

The Quebec & Levis Electric Light Company will apply to the Quebec Legislature at its next session for an act amending its act of incorporation, so as to change the corporate name; to grant power to purchase and lease lands and water powers, to build, lease or sell dams, flumes, canals, power, power stations, mills and electrical appliances.

The largest electrical generator ever installed in Canada is going into the power station of the Ottawa Street Railway. It weighs 33,000 pounds, and will furnish current for the road and for use in heating appliances with which the power house is to be equipped. This will probably be the first building in America heated throughout by electricity.

The Intercolonial Railway has added 500 incandescent lights to the number already in use at Moncton, N. B. The offices, shops, station houses, and in fact all the railway buildings are now lighted by electricity. Over 1,000 incandescent and many arc lights are in use for general lighting purposes. The Westinghouse alternating system is the one adopted.

Montreal.—It is rumored that L. J. Forget, of the Street Railway Company, will shortly be made a director of the Richelieu & Ontario Navigation Company. Some significance is being attached to the visit of Messrs. Forget and McKenzie to New York. Both of these gentlemen are interested in Montreal Telegraph stock, Mr. McKenzie being a director in the company.

Mr. W. A. Grant, so well known along the line of the Canadian Pacific Railway as the obliging secretary of president Van Horne, is about to leave the service of that company. Mr. Grant has accepted the position of manager of the Niagara Falls Electric Railway, which, when opened next spring, will carry passengers from Niagara-on the-Lake to the Falls.

The Great Northwestern Telegraph Company has secured the exclusive telegraphic privilege over the new route of the Adirondack & St. Lawrence Railway Company, which has just been opened. The company is also engaged in constructing a line from St. Johns to Farnham, which will give a new direct wire from Montreal to St. Albans over the Central Vermont Railway's system.

Guelph, Ont.—The merchants and others interested seem to be somewhat jealous of the proposed electric railway between Hamilton and Guelph. They have an idea that it will divert the trade which naturally comes to Guelph now to Hamilton, and that such a railway would be an injury to the city unless it was extended northward. The matter will be considered before the Board of Trade.

Amherstburg, Ont.—There seems to be a misunderstanding of the terms of the Electric Railway by-law. The proposal is practically only a grant of $13,900, for, without government aid, there is little prospect of its construction, and the granting of that assistance will reduce Amherstburg's contribution by $11,100. Only $10,000 is proposed for electric railway connection from Richmond street to Sandwich Town.

The Montreal Street Railway Company recently held its first annual meeting since it changed hands. The report showed that for the past three months there has been an increase of 50 per cent. in the passengers carried. The number carried in the three months was 4,485,327. The past year's business shows a net profit of $93,880 21, against $60,361.71 for the previous year. Two dividends of four per cent. each have been paid.

London, Ont.—A special meeting of the Board of Works has been held to consider a proposition from the Bell Telephone Company to lay an underground conduit for the company's wires from its office, Dundas street, to the corner of Dundas and Richmond streets. The proposal is made by the company in consideration of the probable placing of an electric street car system here, which might lead to serious trouble with their wires.

St. John, N. B.—The electric power station of the Consolidated Electric Company is being greatly improved. The addition that has been erected in the upper end of the station to hold the machinery for furnishing the power for the electric cars has been all opened out. At the lower end of the station or boiler house a 200 h. p. Manning vertical boiler has just been put in and will furnish the steam for running most of the dynamos in the new extension.

The Quebec & Levis Electric Light Company, which recently purchased the famous Montmorency Falls and mills from the Ball estate for a quarter of a million dollars, intends to apply to the legislature next session for power to change the corporate name, to purchase and lease lands, rivers, lakes and water powers, and to build, manufacture, lease and sell dams, flumes, canals, power, mills, and all kinds of electrical apparatus and appliances.

David Blackley, accountant, of Hamilton, has caused a writ to be issued against the Toronto Street Railway Company, claiming $20,000 damages for the death of his son, Ralph Blackley, who was killed on Oct. 1 in Toronto. The writ charges that the young man's death was due to the fact that the strip between the car tracks in Toronto, commonly known as the devil's strip, is too narrow for the safety of the traveling public, also that the employés of the company were negligent in allowing the deceased to ride on the side of the car when they knew that he could hardly escape being killed if he remained in that position.

The Brantford Electric Light and Power Company which was launched some time ago, seems likely before long to be an accomplished fact. The object of the company is to build a new stone drain on the Grand River at a cost of $10,000, the deepening of the canal, and the reclaiming of all waste land surrounding it, through the city, a vast increase of the power at the electric station, near the locks, and the sale of electric power as well as light. In addition to the stock and plant of the present company nearly $40,000 has been subscribed as stock in the new company.

The City Council of Kingston, Ont., is negotiating with the Street Passenger Railway Company for an electric street car service for twenty years. The terms upon which the charter is to be granted are that the company is to pay to the city annually the sum of $200 per mile for single track and $300 per mile for double track, for rent and keeping roadbed in repair; also the following percentages on gross receipts, viz.: When the total gross receipts reach $15,000 per annum, three per cent; when they reach $20,000 per annum, four per cent. on the gross receipts; and when they reach $30,000 per annum and upwards, six per cent. on the total gross receipts.

The latest application of electricity for commercial purposes has recently originated with a mechanical electrician of Ottawa. The idea is to use electricity to take the place of natural ice and cooling chemicals so largely used during the summer months. The details of the invention, which are now being perfected, consist primarily in the withdrawal of heat from cast iron blocks until they are reduced to the temperature of ice water; these blocks to be placed in refrigerators and connected with the electric current, having the same effect as ice without its inconvenience.

President Cronyn, of the London (Ont.) Street Railway Company, has sent the following offer to the City Council: "Understanding that the matter of this proposal is to be reconsidered by the City Council at an early day, we desire to remind them of what we had previously intimated, namely, that the London Street Railway Company is prepared to substitute electricity for horses upon all their lines; and to make such extensions of their present system as public necessity demands upon such terms, as to fares and other concessions, as may be agreed upon between the Council and the company."

The Directors of the Montreal Street Railway Company have decided to set aside a sinking fund from the gross receipts which shall be known as the insurance fund. From this fund the company will insure itself against accident instead of insuring in accident insurance companies. Any surplus from the fund remaining over at the close of the fiscal year will be divided among the drivers and motor men according to their record. That is to say, the driver who has run the most mileage without any accident will receive a bonus, and so on in proportion. This is the first time such an experiment has been tried.

The London (Ont.) and Lucan stage line promises to take the lead in electric enterprises. Mr. J. W. Orme, the owner of the line, is, after two years' search and experimenting, about to give an order for a grand electric 'bus, of sufficient dimensions and strength to accommodate all the needs of passenger and freight traffic over the line. The cost of the electric road vehicle is estimated to be about $2,000, and it is expected to be ready by May 1 next. The power will be got from the improved storage battery and a 6 h. p. motor, and the distance from London to Lucan, 17 miles, will be covered in less than two hours.

News of the Week.

THE ELECTRIC LIGHT.

Anderson, Ind., is to have a $35,000 electric plant.

Allegan, Mich., is to be lighted by electricity.

Yoakum, Tex.—A contract has been let for an electric light plant.

Holly, Mich., will be electrically illuminated in the near future.

The Thomas Furnace Company, Niles, O., is to put in an isolated plant for the lighting of its establishment.

Williamsville, N. Y.—It is reported that as soon as the power house is completed the town will be lighted by electricity.

The Washington Park Club, Chicago, has contracted for a N. Y. Steam Power Company's 50-h. p. engine and Edison electrical plant.

Nunda, N. Y.—A contract has been signed for 27 arc lights of 1,200 c. p. at a cost of $1,500 per year. The plant is to be in operation before June 1 next.

Highland, Ill., is to have an electric lighting plant with General Electric Company's apparatus and N. Y. Safety Steam Power Company's steam plant.

The Hotel Arragon, Atlanta, Ga., has been equipped with a steam plant consisting of two 50-h. p. "N. Y. Safety Steam Power" engines and General Electric Company's apparatus.

Wisconsin capitalists are considering the possibility of establishing a gigantic electric light plant at Kilbourne City to furnish light and power to La Crosse and other cities. The power will be obtained from a dam in that region.

The Northwest General Electric Company has purchased a plot of ground at Dillon, Mont., upon which to erect an electric light plant. The original franchise of the company provides that the plant must be completed by Dec. 10, but an extension of time has been asked for.

The City Council of Roanoke (Va.) has awarded to W. H. Mackay & Co., electrical engineers and contractors, a five years' contract for 100 arc lights and a franchise for 15 years, with permission to erect poles and string wires through the streets within the corporate limits of Roanoke.

THE ELECTRIC RAILWAY.

Kendallville, Ind., is making efforts to secure an electric street railway.

Gustavus J. Melms has been appointed the receiver of the Milwaukee Electric Railway.

Dayton, O.—The Third street line of the Dayton Street Railway Company will undoubtedly be equipped with electricity.

The Metropolitan Railroad Company, of Washington, D. C., will have a few storage battery cars running on regular time in the course of a few days.

The Cambridge (Mass.) Storage Battery Electric Street Railway Company has petitioned the Railroad Commissioner for a certificate for a charter.

The Niles (O.) Commissioner has accepted the franchise presented by the Mineral Ridge & Niles Electric Company for an extension of the line to Girard.

The Carey street line of the Baltimore Traction Company is nearly completed, and as soon as a special curve is put in at Fayette street and Carrollton avenue the road will be ready for electric traction.

Electric heaters are to be placed in the cars of the Brooklyn Street Railway Company, of Cleveland. The Dewey system will be used. The Brooklyn road has been making a thorough test of the Dewey electric heaters since the Cleveland convention.

New Orleans Street Car System Sold to a New York Syndicate.—It is reported that a New York syndicate has purchased the street railroad system of New Orleans for $10,000,000, and the motive power will be changed from mules to electricity.

The Lake Roland Elevated Railroad Company has 300 men employed laying track from Stony Run to Roland Park. Nearly one half of the 400-foot iron viaduct over Stoney Run has been completed, and the material for the rest is on the ground. The same company has just closed a contract with the Burton Electric Heating Company, of Richmond, Va., for equipping all its cars with Burton heaters. There will be five heaters on each car; one on each platform and three inside; and a temperature of 75 degrees is guaranteed. Tests are also in progress on this road of various kinds of cross-overs, those in use having given some trouble.

New Orleans Street Railways.—A syndicate represented by the banking firm of J. & W. Seligman & Co., No. 21 Broad street, this city, has purchased the entire street railway system of New Orleans, or the greater part of it. The compensation is said to be $10,000,000. It is said that many New Orleans stockholders in the old companies have purchased stock in the new concern, and that the new York capital which is needed will be used to improve the system. The motive power of the lines comprising the big corporation at present is mules. Under the new organization it is to be changed to electricity. The new purchase includes a number of valuable railway franchises, and Mr. Seligman said that it was the intention of the syndicate to develop fully the street railway system of New Orleans and to establish a good transfer system, which is badly needed.

Industrial and Trade Notes.

Queen & Co., of Philadelphia, are meeting with unusual success in the sale of their Cardew voltmeters.

The Tojo Mining Company, of Mazatlan, Mex., will use a N. Y. Safety Steam Power Company's 50-h. p. high speed engine for driving dynamo for mine lighting.

The Peckham Motor Truck and Wheel Company, 45 Broadway, New York City, is enlarging its shops at Kingston, N. Y. The force has been increased and work is carried on day and night.

A. L. Bogart, 22 Union Square, New York City, has made important improvements in his electric gas lighter, which he now claims is practically indestructible—an appropriate Christmas present.

The Rich Electric Company has erected a laboratory at Mt. Vernon, N. Y., and proposes to place upon the market apparatus for electric heating and cooking.

The Anglo-American Electric Manufacturing Company is manufacturing a variety of electrical apparatus for export purposes. This company deals almost entirely with South and Central American countries.

Paradox shades, manufactured by the F. Holman Electrical Company, although but a short time on the market, are being recognized as among the best. During the past week over 35 dozen of these shades were sold; 15 dozen of which were shipped to London.

Seib & Starke, 411-413 East 107th street, New York City, are placing upon the market some new motors, and an electric door opener, both of which have met with great success. This firm is now located in very pleasant and convenient quarters and reports business good.

A "New York Safety" Engine is to drive the electrical plant of the Harlem Wood and Lumber Company, 138th street, New York. Another 100-h. p. "New York Safety" engine is being erected in Wm. Campbell's paper hanging manufactory, Tenth avenue, New York, for driving an electric lighting plant.

Charles A. Schieren & Co., 45 to 51 Ferry street, New York City, have received a contract for all the belting for the New York Herald Building, to consist of belts from 35 inches down to 12 inches; and also large orders from the Gas and Electric Company, of Wichita, Kan., and the Lima, O., Electric Light and Power Company.

W. R. Brixey, manufacturer of the well known Kerite insulating wires and cables, is making two additions to his already large factory; one of these is 120x43 ft. and the other 60x45 ft. He is also putting in a new Abendroth & Root water tube boiler, of 155 h. p. a; Green horizontal engine of 125 h. p., and has just erected a 400-light Edison plant.

The Utica Electrical Manufacturing Company is now manufacturing the Russell mast arms and has taken a large order from the Cincinnati Edison Electric Company, and also one for arc cut-outs. It is also wiring the Globe woolen mills, Utica, for 1,600 incandescent lights. Two Edison dynamos are now in, and two Wood incandescent machines will be furnished to complete the work. This firm is very busy in all its departments.

The Bowsher Balancing Ways have met with an ever increasing demand among manufacturers and machinists. Some of the more important firms which have recently added this piece of apparatus to their shops are: The Stanley Manufacturing Company, Pittsfield, Mass.; H. L. Beach, Montrose, Pa.; D. E. Evans & Co., Baltimore; J. A. Fay & Co., Cincinnati, O., and the Edison General Electric Company, Schenectady, N. Y.

The New Jersey Lamp and Bronze Works, factory at New Brunswick, N. J., New York office 44 Murray street, desires to receive original designs for electrical fixtures or appliances, which if used, will be liberally paid for. This company is anxious to get as far away as possible from the cumbrous and conventional gas fixture which has been adopted so generally for electrical work, and to obtain some design which is more ornamental and graceful.

Truex & Vail, of 136 Liberty street, still continue to receive many orders not only from this, but from foreign countries for their swinging ball lightning arrester, notwithstanding the fact that it is between seasons. The Walker ammeters, of which this firm is the exclusive manufacturer, are, as usual, receiving their due recognition in the way of orders. They report the storage battery business as exceedingly good, with several prospective contracts for quite a number of cells.

The B. F. Sturtevant Company has purchased the 4-story building at 135 North Third street, Philadelphia, Pa., where it has been leasing the store and basement, and is now refitting the same and putting in a complete line of stock. The loft overhead is being arranged for a sheet-iron apartment, where it is proposed to make the sheet-iron pipe used with the Sturtevant blowers, heating and ventilating apparatus. This branch has been placed in the charge of Mr. C. H. Gifford, who for the past 15 years has been connected with this company at Boston.

The Safety Insulated Wire and Cable Company, of which Mr. L. F. Requa is the general manager, located at 234 W. Twenty ninth street, New York City, is rapidly extending its business. The quarters at present occupied are being extended through the block to Twenty-eighth street, where they will have a frontage of 125 feet. Work on this extension is being rapidly pushed so as to be in readiness before the first of the year. This six-story building will add greatly to the company's facilities for doing business. A specialty is to be made of submarine cables.

The Chicago Electric Wire Company, of Wilmington, Del., of which Wm. Weightman is president; Edward T. Davis, secretary and treasurer, and H. B. Cobb, superintendent, has orders on hand for nearly 1,000,000 feet of wire for inside wiring. The company's present output is 40,000 feet a day, but it is making arrangements to double this capacity. The company manufactures everything in the insulated wire line, and having a large capital behind it is determined to spare no expense to make its establishment the largest and most perfect one of the kind in the country. Mr. Cobb has done excellent work in this line and his friends and the trade generally will be glad to learn of his merited success.

The Tice-Lintner Electric Company, Minneapolis, Minn., is placing on the market a new potential indicator, which is designed to produce a wide range of movement of the circuit-closing

pointer for a limited variation of potential. The instrument has two independent armatures or cores acted upon by the field of a solenoid, and to one of these is attached the pointer. The two armatures are prevented from coming sufficiently near each other to prevent their mutual attachment overcoming that of the solenoid. The object of this arrangement is to concentrate as much as possible the power or action of the instrument within the safe working limits of a constant potential system on which it is placed.

The Sperry Electric Mining and Machine Company has just received the following letter from Geo. H. Meeker, Chicago manager for the New York Insulated Wire Company: "In placing with you our order for fuse wire and likes to be used in the Westinghouse Electrical and Manufacturing Company's installation for the entire incandescent lighting of the grounds and buildings of the World's Columbian Exposition, we do so as we believe your fuse wire and links are the best and most accurate in the market. The conditions of our contract are such that it is necessary for us to have the very best. We place the order with you without hesitation, believing that your goods are uniform and standard and will meet the specifications of our contract."

The E. G. Bernard Company, Troy, N. Y., is doing a splendid business in its new safety porcelain cleat for electric wires and also in its perfect arc cut-out, with weatherproof cases and insulated wire poles, made with metal or glass face. This company handles a full line of all kinds of electrical supplies, and having bought out Joseph A. Powers' machine shop will remove it to Fourth street, between Broadway and Fulton, where manufacturing and repairing of dynamos, armatures and other electrical work will be continued. Joseph A. Powers has sold out his electrical machine shop to the E. G. Bernard Company, Troy, N. Y., having accepted a position as manager of the Glens Falls, Sandy Hill and Fort Edwards electric street railway.

The Caldwell Water Tube Boiler has recently received important improvements at the hands of its inventor, Mr. John A. Caldwell, which materially affect the steaming capacity. This boiler is manufactured by the firm of D. A. Burrell & Co., Poughkeepsie, N. Y. This company has recently placed on the market a new departure in "dry pipes," applicable to any type of boiler, and which prevents flooding the engine under any circumstances. The following are among the recent orders for the Caldwell water tube boiler, whose headquarters is 15 Cortlandt street, New York City: H. J. Hoerner & Co., Newark, N. J., one 60 h. p. boiler; Johnson Railroad Signal Company, Rahway, N. J., one 120 h. p.; Polson Iron Works Company, Toronto, Ont., one 984 h. p.; Norfolk, Albemarle & Atlantic Railroad (Princess Ann Hotel, Virginia Beach, Va.), one 110 h. p.; Tiffany & Company, Jewelers, New York City, (new factory Newark, N. J.), one 103 h. p. This company has secured the services as selling agent of Mr. P. M. McLaren, who for many years held a prominent position with the Babcock & Wilcox Company.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Oil Filter for sale cheap; send for prices to Purity Oil Filter Manufacturing Company, 91 Water street, Pittsburgh, Pa.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Beacon Incandescent Lamps of 16 c p. are offered at 35 cents each, as will be seen from the full-page advertisement of the Beacon Vacuum Pump and Electric Company which appears in this issue of THE ELECTRICAL WORLD. The company claims that the quality of the lamp is unrivaled, and guarantees to the users perfect satisfaction. The company also offers its 16 c. p. anchored filament railway lamps for 40 cents each.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

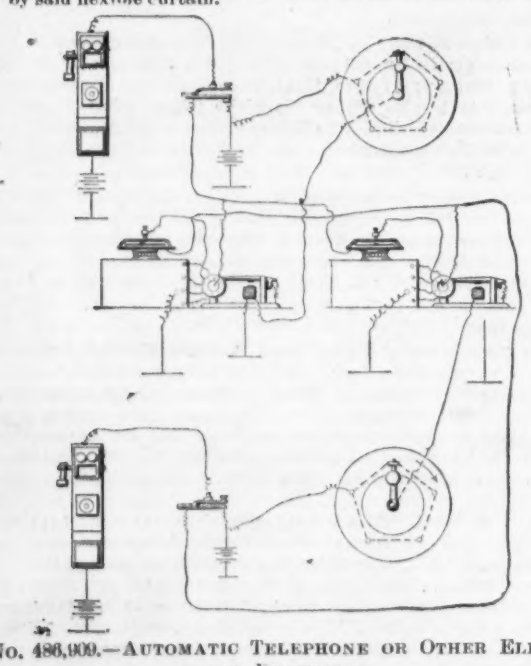
UNITED STATES PATENTS ISSUED NOV. 29, 1892.

486,879. Magnetic Separator; J. Lovett, Chicago, Ill. Application filed Feb. 13, 1892. In a magnetic separator the combination of a wheel which has a plurality of magnets set in its periphery with alternate north and south poles pointing outward, a drum which surrounds said wheel, an idler pulley, an endless belt which runs around said pulley and drum, mechanism for rotating said wheel and drum at different rates of speed and an inclined feed-chute arranged tangentially to said wheel and drum.

486,888. Electrical Transmitting Apparatus; A. D. Neal Boston, and H. F. Eaton, Cambridge, Mass. Application filed April 17, 1891. In a system for the transmission of characters or letters, the combination, with a main line and a character controlling magnet located therein, of an electro-magnet having its armature in a normally open circuit connected to the main-line circuit, a substantially continuously moving surface provided with one or more circuit terminals in circuit with the said electro magnet, a circuit terminal in circuit with the electro-magnet and co-operating with the circuit terminal on the movable surface, a locking bar for the armature of said electro-magnet, a second electro-magnet to operate the locking bar located in a normally closed circuit and character keys adapted when operated to open the normally closed local circuit and close the normally open circuit

486,902. Galvanic Body Battery; J. W. Shults, Wichita, Kansas. Application filed March 22, 1892. A galvanic electric battery consisting of a body portion of vulcanized rubber provided with a receptacle therein for holding an exciting material, and with a perforation leading from the receptacle to the face of said body portion, of metallic elements of an electric battery set in, or fixed to said body portion, and of electric conductors arranged connected with the poles of the battery and terminating with electrodes.

486,908. Burglar Alarm Cabinet; A. Stromberg, Chicago, Ill. Application filed July 9, 1892. In a cabinet entirely surrounding a safe, the combination with a flexible curtain adapted to be raised to give access to the safe door, of swinging stanchions provided with channels which act as guides to said flexible curtain and a sill and contact points on said sill, adapted to make contact with plates connected to the circuits which are carried by said flexible curtain.



No. 486,909.—Automatic Telephone or Other Electrical Exchange.

486,909. Automatic Telephone or Other Electrical Exchange; Almon B. Strowger, Chicago, Ill. Application filed Feb. 19, 1892. In an automatic electrical exchange, the combination, with a table having a series of wires secured thereto, of a switch the contact point of which is adapted to be placed in electrical connection with any one of the wires, the table being concentrically adjustable relatively to the switch. (See illustration.

486,916. Electrical Transformer; Elihu Thomson, Swampscott, Mass. Application filed May 23, 1892. A transformer for electric circuits having means for automatically varying the effective inductive length of one of its windings in a continuous unbroken manner simultaneously with the change in load.

486,926. Coil for Electrical Apparatus; H. C. Buck, Somerville, Mass. Application filed Dec. 5, 1884. A coil made up of a series of spiral coils, each spiral separated from the spirals under and over it by a cylinder of thin insulating sheet material and each convolution of each spiral separated from its neighbors by the plastic insulating coating of the insulating sheet.

486,958. Electric Arc Lamp; C. E. Scribner, Chicago, Ill. Application filed Jan. 2, 1883. The invention consists in the lifting magnet included in the main circuit, a fine wire magnet included in a shunt around the arc and a shunt around both of these magnets and including resistance and contact points adapted to be controlled by either of said electro-magnets to open or close the said shunt circuit including the resistance.

486,985. Trolley for Conduit Railways; B. Olbricht. Application filed May 17, 1892. The combination with a casing, the top plate of which is provided with a longitudinal slot of metallic conductors attached to the under side of said top plate, a hinged and spring actuated arm adapted to be suspended from a car, the trolley at the lower end of the arm the rollers of which are in contact with the conductors, and protecting casings suspended from the pivots of the rollers and provided with lips or flanges at the ends.

486,987. Incandescent Switch; W. J. Schultz, Detroit, Mich. Application filed June 27, 1892. In an electric switch, the combination of a brush holder, the bifurcated handle, having a common pivot with said brush holder, said handle adapted to depress said brush holder at one extremity of its movement, and to elevate the same at the other extremity of its movement by a striking contact therewith and a spring adapted to force said lever in either direction, whereby the same is caused to strike said brush holder, and to make and break the contact quickly.

487,002. Safety Device for Electric Circuits; G. Cutter, Chicago, Ill. Application filed Feb. 19, 1892. The combination of a box with separated contact pieces within the same with an aperture through a portion of such box, a movable part whereby the dimensions of such aperture may be varied, and a series of fuse carrying blocks of various outline to correspond to the variations in the aperture made by such movable part.

487,022. Adjustable Electric Light Holder; L. S. Pfouts Canton, O. Application filed Feb. 24, 1892. The combination of a casing, having located therein a rotating shaft, an insulated disc, mounted upon said shaft, a spool fixed to the shaft, a spring fixed to the shaft, pendant arms, a sliding tube, a metal collar located within the insulating collar and a pivoted arm.

487,046. Electric Light Carbon; J Clegg, London, Eng. Application filed April 10, 1890. In the manufacture of luminants for arc lamps, the treatment of carbon filaments to cause a deposit on them of metallic matter, which consists in electrically heating them to incandescence while they are suspended in a vessel from which all air is excluded above a volatile liquid such as alcohol having dissolved or suspended in it an oxide of some one or more suitable metals.

487,049. Incandescent Lamp; J. H. F. Görges, Berlin, Germany. Application filed April 20, 1892. An incandescent lamp provided with three terminals connected with each other through three independent carbon filaments of equal resistance. (See illustration.)

No. 487,049.—Incandescent Lamp.

487,073. Magnetic Separator; Thomas J. Lovett, Chicago, Ill. Application filed Feb. 13, 1892. In a magnetic separator, the combination of two magnetic wheels of different magnetic intensity, two idler pulleys, two endless belts, each of the belts running around a magnetic wheel and one of the idler pulleys, and an inclined feed chute which has horizontal ridges in its bottom and is arranged tangentially to both of the magnetic wheels.

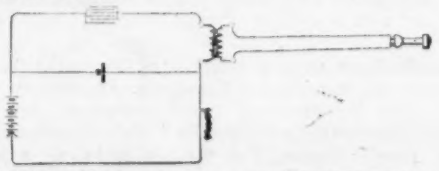
487,074. Magnetic Separator; Thomas J. Lovett, Chicago, Ill. Application filed Feb. 13, 1892. In a magnetic ore separator, the combination of a crescent frame, rotating magnets journaled in the frame, idler rollers arranged on the convex side of the crescent frame, the endless belt which runs around the frame on the idler rollers, and the driving mechanism for the belts and magnets.

487,092. Electric Switch; John J. Nate, Chicago, Ill Application filed March 29, 1892. The combination, with the hand rope of an elevator, of a switch adapted to close the circuit through the field coils of an electric motor when moved in either direction, a rheostat in circuit with the armature of the motor, the rheostat being provided with duplex contact points arranged symmetrically upon either side of a dead-point, a contact-arm adapted to traverse the contact-points and connected with the hand rope to permit of lost motion, so that when the hand rope is moved in either direction the circuit through the field coils may be closed in advance of the circuit through the armature and an increasing current through the armature.

487,093. Electric Current Indicator; Charles P. L. Noxon Syracuse, N. Y. Application filed Nov. 24, 1891. In a current indicator, the combination, with an electric circuit, of a transparent receptacle of an inverted T shape and a heat and electric conducting fluid in the receptacle, the terminals of the circuit entering the ends of the lower horizontal member of the receptacle.

487,095. Auxiliary Fire Alarm Signal Apparatus; Charles E. Scribner, Chicago, Ill. Application filed June 1, 1888. The combination, with an auxiliary fire alarm signal box; of an auxiliary circuit, including a source of electricity and an electro-magnetic signal device in a shunt of the circuit, the circuit being connected with a circuit breaking device which is operated by the fire alarm signal box to break the circuit when the fire alarm signal box is brought into service, whereby the auxiliary circuit is interrupted to cause the electro-magnetic signal device included in shunt thereof to cease operating.

487,096. Multiple-Switchboard System; Charles E. Scribner, Chicago, Ill. Application filed March 5, 1892. A connecting-plug consisting of a central conducting-core, a conducting sleeve concentric with and insulated from the core, and of such a length as to leave a portion of the core exposed, and an insulated tip secured to the core.



No. 487,102.—Development and Distribution of Electricity.

487,097. Telephone Exchange System; Charles E. Scribner, Chicago, Ill. Application filed Nov. 29, 1892. The combination with several telephone sub-stations of line circuits, one for each connection, extending to an exchange and connected to a spring-jack upon each of several switchboards, several calling circuits, each extending to several sub-stations and including an electro magnetic indicator at a different switchboard, and means at each sub-station for including a source of electricity in any one of the calling circuits extending thereto.

487,098. Telephone Switchboard Apparatus; Charles E. Scribner, Chicago, Ill. Application filed April 21, 1892. The combination with a connecting plug of a switch-lever held in one position by the plug when out of use, switch-contacts thereon, and means for retarding the motion of the switch-lever.

487,102. Development and Distribution of Electricity; John S. Stone, Boston, Mass. Application filed Oct. 10, 1891. The combination in a system of telephonic transmission of a variable resistance transmitter, a source of electricity, and a suitable resistance associated in an electric circuit with a condenser connected in a shunt of the circuit round the transmitter and a receiving telephone connected directly or inductively with the condenser shunt. (See illustration.)

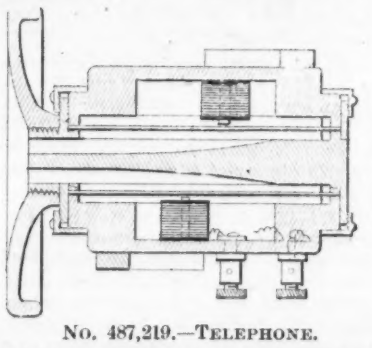
487,109. Automatic Electric Lighting Apparatus; Leonidas G. Woolley, Grand Rapids, Mich. Application filed June 6, 1892. An electric lighting apparatus comprising a motor, a motor-valve-controlling mechanism, a movable electric generator driven by the motor, an operating connection between the valve mechanism and generator, an external circuit including electric lights or motors and an electric device within the circuit for locking and releasing the valve mechanism.

487,114. Electric Locomotive; Conrad M. Conradson, Madison, Mich. Application filed Dec. 2, 1892. In combination with a shaft or axle to be driven, an electric motor, and gearing interposed between the motor and the shaft or axle and adapted at the will of the attandant to positively lock together the rotating member of the motor and the shaft or axle, and thereby cause them to move as one.

487,128. Burglar Alarm; Harry W. Reynolds, Long Branch, N. J. Application filed April 6, 1892. A burglar alarm comprising a vertical plate provided on its front face with an outwardly projecting post, an arm pivoted between its ends on the post and projecting below the back plate, an insulating washer on the back plate above the post, a bolt extending therethrough, a spring having an upwardly projecting apertured arm receiving the bolt and clamped to the washer by a nut, the spring being curved downward, outward and upward from its point of attachment over the post and in the path of the upper end of the arm, binding posts secured to the back plate, and having insulating washers, and electric circuit connections.

487,154. Telegraphic Apparatus; Josiah A. Parker, St. Louis, Mo. Application filed Jan. 27, 1891. In a system of telegraphy over a single line wire using keys adapted to be pressed down simultaneously, an interlacing arrangement of electrical contacts by which no two signals are completed at the same time, and one series of contacts does not conflict with the other series, although the parts of one may be parts of another.

487,176. Process of Electro-Depositing Alloys; Sherard Osborn Cowper Coles, London, England. Application filed Nov. 18, 1891. The method of depositing by electrolysis an alloy of silver and any known metal or metals other than the rare metals, which has or have a specific gravity between 6.5 and 9.0 at 15 degrees centigrade and boils or boil at a temperature between 710 degrees centigrade and 1,945 degrees centigrade under the ordinary atmospheric pressure on metals and other suitable articles, wherein the articles to be coated are placed in a bath of the double cyanides of such metal or metals and silver and potassium, and an anode is employed consisting of an alloy of the metals to be deposited in approximately the proportions of the required deposit.



No. 487,219.—Telephone.

487,185. Electric Belt; John H. Johnson, Dodgeville, Wis. Application filed July 21, 1892. In an electric belt, an electrode consisting of a flat plate and hinged clasps adapted to surround the belt, provided, respectively, with a staple and a slot.

487,213. Incandescent Lamp Socket; Charles B. Elliott, Boston, Mass. Application filed Aug. 8, 1892. An electric lamp socket having a rigid body, contact poles molded permanently therein and provided with coupling contacts rigidly held at one end of the body in a plane at right angles to that of the poles, the contacts being connected within the body by the wires.

487,219. Telephone; Hammond V. Hayes, Cambridge, and Wilton L. Richards, Malden, Mass. Application filed Sept. 10, 1892. A compound or double-circuit telephone having for each circuit an independent diaphragm and inducing helices and magnet, being arranged substantially perpendicular, or at right angles with each other, whereby reciprocal inductive neutrality is secured. (See illustration.)

487,220. Electrode for Arc Lamps; Charles W. Hazeltine, St. Louis, Mo. Application filed May 6, 1892. An electrode for arc lamps provided with a metallic coating protected by a suitable outer covering of a different character carried by the electrode.

487,227. Electrical Type-Writer; Albert D. Neal, Boston, and Howard F. Eaton, of Quincy, Mass. Application filed May 27, 1892. In a type-writer system of communication, the combination, with a type writer located at one station and a plurality of circuit controllers co-operating with the keys of the type-writer, located at a receiving station and having its character-levers operated by movement of the armatures of electromagnets in circuit with the circuit controllers, a carriage, an impression-roller carried by the carriage, a ratchet wheel to rotate the roller, an arm provided with a pawl to actuate the ratchet wheel, and a cam to act on the arm to produce rotation of the ratchet wheel.

487,228. Electric Type-Writer; Albert D. Neal, Boston, and Howard F. Eaton, Quincy, Mass. Application filed May 27 1892. In a type-writer, the combination, with a movable carriage and a carrier to which the carriage is attached, of a motor mechanism, consisting of a main shaft provided with a gear, a segmental gear in mesh with a pinion on a shaft on which the carriage is mounted, and intermediate gearing to connect the segmental gear with the gear on the main shaft, and an electro magnet to rotate the main shaft in a direction opposite to the movement of the drum.

487,229. Printing Telegraph; Albert D. Neal, Boston, and Howard F. Eaton, Quincy, Mass. Application filed April 21, 1891. The combination, with a type-writer having its key-levers operatively connected to the armatures of electro-magnets, of circuit-controllers for the electro magnets adapted to be operated by the key-levers, a circuit-controller actuator, moved independently of the key-levers, and a locking device for the armatures.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.